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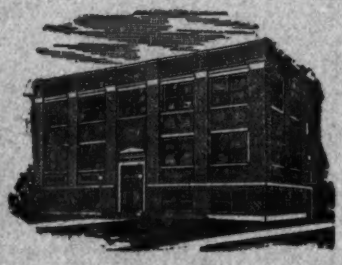

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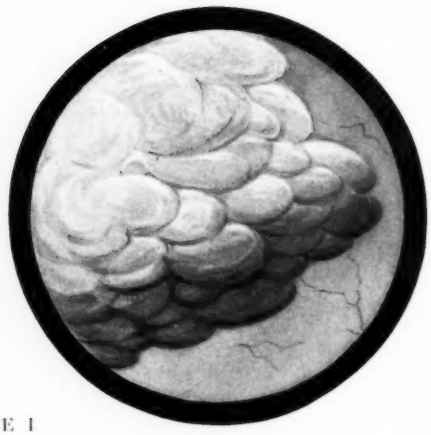

PLATE I

Fig. 1. Cystoscopic view of right portion of bladder looking toward the trigone and showing vegetating syphiloma. The points of the papillæ are arranged in peaks and have a silvery gray color.

Fig. 2. Cystoscopic view of left portion of bladder, same case, looking toward the trigone

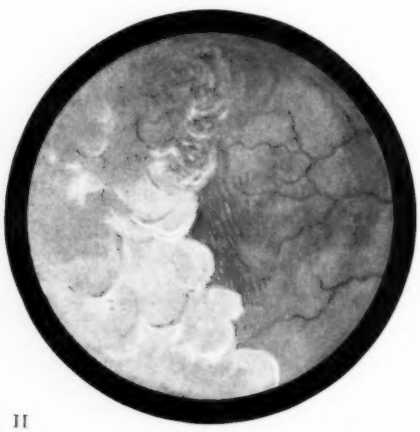

PLATE II

Fig. 1. Cystoscopic view of right portion of bladder looking toward the trigone and showing vegetating syphiloma of the bladder two weeks after continuous treatment. Uretera opening plainly visible in crater-like mass.

Fig. 2. Cystoscopic view of left portion of bladder looking toward the trigone.

SURGERY, GYNECOLOGY AND OBSTETRICS

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TUMORS OF THE BLADDER

INCLUDING REPORT OF VEGETATING SYPHILOMA OF THE BLADDER

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DURING the last 7 months, there have come under our observation 7 cases of bladder tumors. Three of these were carcinomata, 3 papillomata, and 1 condyloma of the bladder. The discovery that condyloma could exist in the bladder and simulate a true tumor growth so closely that cystoscopically they were apparently identical, came as a surprise to us. It is with a view of reporting our findings in this interesting case, as well as our experience in treating the remaining cases of neoplasm, that we present this report.

CASE 1. A young woman of 25 entered the hospital on the service of one of us (D), December 11, 1919, complaining of pain over the lower abdomen, painful and frequent urination, loss of weight; 22 pounds in last 2 months.

Previous history. The patient had measles, chicken pox, and scarlet fever as a child; neisserian infection 3 years ago; criminal abortion in September followed by evacuation of uterus. She states that she had fever for 4 days after this. Menstrual history began at 14, the periods were 4 to 5 weeks apart, and always painful until recently, the flow was scant, and very irregular during past three months.

Family history. The patient has three brothers, one sister; the father and mother are living and well.

Present illness. Since abortion in September last, the patient has not gained strength or regained her appetite and has lost about 15 pounds in weight.

Two months ago she began to be troubled by frequent urination and pain on voiding. The pain was of a sharp and burning character and would subside in the intervals between voiding. She would void every hour or so during the day and would get up from four to five times at night. She has suffered from abdominal pain, which is not localized in any particular spot, but which seems more pronounced over the right iliac region, to lesser degree in left iliac region and slight tenderness over bladder area. The pain is not continuous and not very acute. She tires very easily.

Physical examination shows an anæmic, slender, young woman, distinctly under weight, with no abnormalities. The chest is negative; the abdomen flat, symmetrical, slender; the liver and spleen not palpable; and there is slight tenderness in both lower quadrants; no palpable masses.

Urinary examination on admission showed a specific gravity of 1008, serum albumin present and a very marked pyuria. Examination of urine for tubercle bacillus was repeatedly negative. Smears for gonococci were negative. The Wassermann made 3 days after admission was slightly positive. A second Wassermann done two days later was negative.

Vaginally the anterior wall of the vesicovaginal septum was found to be very distinctly infiltrated, indurated, and immovable, presenting an irregular surface. Cystoscopy showed the entire bladder floor to be occupied by an infiltrating growth with many small peaked projections, of papillomatous character, together with larger, rounded masses, the upper portions of which showed a translucency indicating œdema. Neither ureteral orifice could be

distinguished. The lateral portions of the bladder appeared approximately normal, there being only the evidence of a mild cystitis.

Cystoscopy was repeated at which time we both examined the patient. We were in doubt whether we were dealing with a malignant growth or syphilis. The cystoscopic findings were very distinctly suggestive of malignancy against which spoke the youth of the patient and the evident possibility of the presence of a specific infection. Extensive induration in the vesicovaginal septum would speak for syphilis. On the other hand syphilis of the bladder is a very rare finding.

We decided to do a cystotomy which was carried out by both of us, on December 23. On opening the bladder its fundus and anterior wall were thick, almost 1 centimeter in thickness, stiff, and of a pearly grey color on cross section. The cavity of the bladder was smaller than normal, and its base was occupied by a growth which, on direct inspection, did not appear definitely malignant. A small bit of tissue was secured for section which was examined by Dr. Gladys Dick. She reported that, while the specimen had been somewhat injured by drying before she received it, none of the sections made by her showed malignancy but merely appeared to be necrotic material.

It was then decided to place the patient upon active specific treatment which was done by one of us (C), who gave her salvarsan intravenously nine times. She immediately began to improve, and cystoscopy, after the wound had nearly closed, showed a marked regression of the growth at the base of the bladder, the distinguishing characteristics of which, however, were still plainly evident.

Figures 1 and 2, Plate I show the growth as it appeared at this time. Two weeks later the bladder was still further improved as is shown in Figures 1 and 2, Plate II. She was discharged from the hospital on February 17, at which time the cystotomy wound was entirely healed, the patient's general condition was very greatly improved, and she was gaining rapidly in weight.

Syphilitic lesions of the bladder have not been adequately discussed in the literature. During the period from 1551 to 1767, there is almost complete obscurity although occasionally observations are cited where lesions of this character were discovered at autopsy in individuals dying on account of urinary lesions. During the period from 1872 to 1900 numerous cases of bladder tumors due to syphilis were diagnosed by the therapeutic method; that is, if the symptoms disappeared under treatment it was pronounced syphilitic.

Since 1900 great progress has been made in diagnosing bladder lesions because of the development of the cystoscope. During the same period has been added the Wassermann reaction, a strong supporting evidence in diagnosing these lesions.

So far as we are able to learn, the first dissertation on syphilis of the bladder which has been printed in the English language appears in Cabot's *Modern Urology*, in the chapter on syphilis, which was written by one of us (C). Since that time a number of reports have appeared, and recently Lloyd Thompson in the *American Journal of Syphilis* has reported all the cases up to date, which number 52.

As the case above reported shows that a syphilitic lesion may cause a growth in the bladder which produces all of the symptoms and appearance of a tumor, it would appear to be justifiable to add to the very extensive classification originally proposed by Kuester and Albarran and which Geraghty tells us is almost universally accepted, a new division under the head of granuloma or tumors of infective origin. Under this heading should appear condyloma, the lesion of secondary lues, and gumma, the lesion of tertiary lues. The classification would then appear as follows:

I. Neoplasm
  1. Tumors of connective tissue origin
    a. Benign
      Fibroma
      Myoma
      Fibromyoma
      Angioma
      Rhabdomyoma
      Myxoma
      Chondroma
    b. Malignant
      Sarcoma
  2. Tumors of epithelial origin
    a. Benign
      Adenoma
      Papilloma
      Cystic tumors
    b. Malignant
      Carcinoma
      Adeno-
      Squamous
      Scirrhous
      Papillary
  3. Tumors of obscure origin
      Hydatid cysts
      Dermoid cysts
      Cholesteatoma

II. Granuloma
4. Tumors of infective origin
Secondary lues—condyloma
Tertiary lues—gumma

Syphilis of the bladder manifests itself in the following ways:

1. *Secondary period.* During the time of the generalized eruption, it is not uncommon to find the bladder studded with discrete papules, similar to those appearing on the skin. These findings have been reported by numerous observers. There is also a form of *vegetating syphiloderm* which throughout the literature has been described as "gumma of the bladder," except by Denslow. He reports a case in which he describes a typical picture of condyloma of the bladder. In the case here reported the diagnosis of condyloma was made independently of Denslow's report which we did not see until later.

If one considers that during the period of secondary invasion all the tissues of the body are invaded by the spirochæta pallida, one may easily assume that that which occurs on the skin may easily happen on other surfaces of epithelial character. It may easily be conceived that the changes which occur in a papule on the skin on a moist surface may occur on the moist mucous surface of the bladder. This may occur at any time after the primary invasion. According to Thompson, this moist, papular syphiloderm may occur 30 years after a primary lesion, when no treatment has been used.

The bladder offers a warm, moist bed for the growth and development of the spirochætæ, and the thin mucous membrane of the bladder may be regarded as resembling fairly closely, so far as the conditions which it offers for the growth of the organism are concerned, the condition about the anus. The moist papular syphiloderm instead of becoming flat occasionally becomes warty and papillomatous. Several lesions may coalesce and a large cauliflower mass may develop which we may term a *vegetating syphiloma of the bladder.*

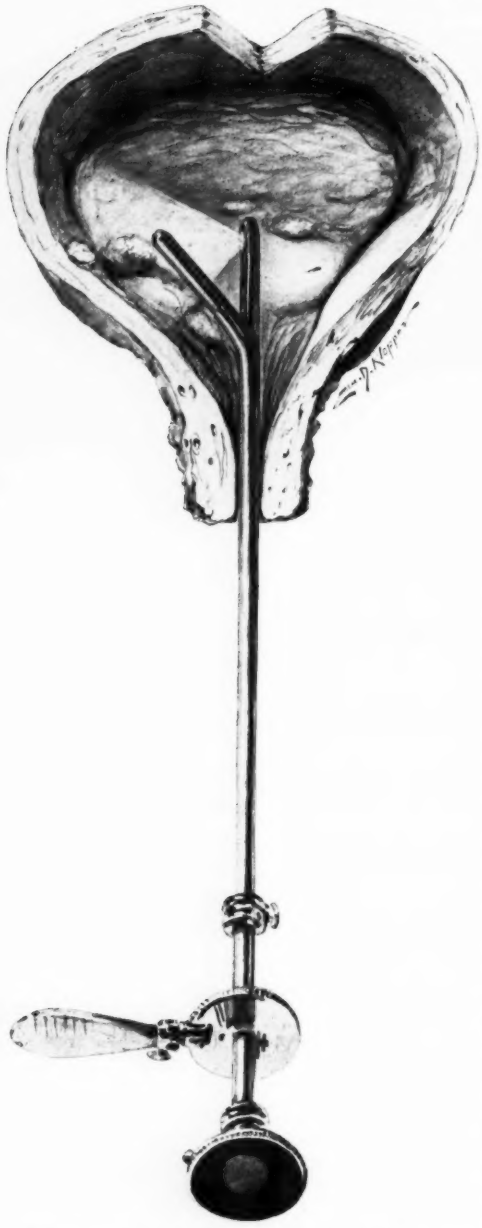
As studied with the cystoscope these tumors simulate a papilloma so closely that it is impossible at times to differentiate between them. In many of the cases reported, these growths are referred to as gumma, as few observers believed them identical with condyloma which occurs upon the skin. It was with a view of stimulating further study of this lesion that the accompanying pictures were made.

In passing a cystoscope over this hypertrophied papillomatous mass, one is impressed with the similarity to bullous œdema. However, by carrying the cystoscope to the border of the mass, the growth in uniform palisades can be differentiated from the normal bladder. The mass is freely movable. So far as the surface portion of the growth is concerned, the papillæ rise and fall under the slightest pressure from the distal end of the cystoscope. The points of the papillæ are arranged in peaks and are of a silver gray color due to their distention, which causes them to be translucent under the cystoscopic light. Looking across this mass through a McCarthy cysto-urethroscope, the papillæ look a little more yellow from the retained serum under the mucous membrane. Seen later and after continuous treatment, the round and oval papillæ show as delicate, pearly, translucent fingers, resembling stalactites. The cysto-urethroscopic picture may be compared to looking over the uneven surface of a lake, the peaks of the waves representing the papillæ, perfectly transparent at their apices and so soft and delicate that they may easily be pushed over with the instrument. In the case here reported, induration at the base was marked and could easily be felt through the vaginal walls.

The histopathology of the vegetating syphiloderm has been described by Dennie as follows:

When sectioned, the lesion is seen to consist of two parts, an upper, dense, finely striated portion, about 4 millimeters thick and a lower narrowed core. Microscopically the former shows many slender epithelial fingers connected above by thin bridges and below penetrating the corium.

Tertiary period. Gumma of the bladder simulates the ulcerative form of papillary carcinoma. This is especially manifest when they are both broken down and covered with mucus. As these tumors may occur during



Corbus cystoscopic radium applicator. Schematic drawing illustrating application of radium to a bladder neoplasm by means of cystoscope. Also serves to show schematic drawing illustrating tumors found in bladder in Case 2. Smaller tumors disappeared after application of radium to the largest one. Tissue examined from largest tumor shows typical papillary carcinoma.

the later periods of life, the time when malignancy generally occurs, a differential diagnosis is important. In arriving at a differential diagnosis one should consider the age of the patient, the history, and the possibility of specific infection.

In this connection it should not be forgotten that carcinoma may co-exist with lues and the presence of a positive Wassermann reaction therefore is not necessarily conclusive. If possible, tissue should be secured by the operating cystoscope, or, should a cystotomy be made, and the diagnosis still be in doubt, tissue may be taken for microscopic study.

The cases of neoplasms of the bladder which we wish to record are as follows:

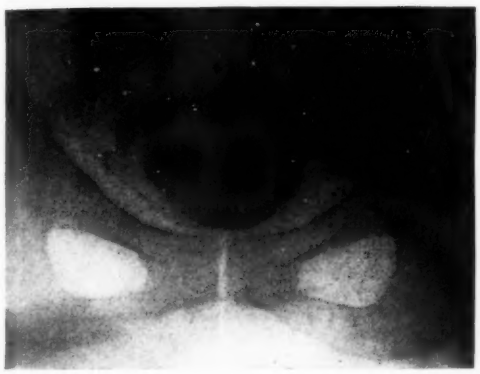
CASE 2. Married woman, age 36. Referred to one of us (C) by Dr. M. H. Mack.

Family history. The patient is the second child in a family of five children, two boys and three girls. The father died of pneumonia, at the age of 56. The mother died of paralysis, following an accident, at the age of 57. A brother, 2 years older than the patient, died after an operation for complete obstruction of the bowels, when 34 years old. The other brother, 19 months younger than the patient, died of measles, when 2 years and 6 months. Two sisters, aged 25 and 31, are living. All grandparents lived to be 70 years or more.

Present illness. About 14 months ago the patient began to notice that it was difficult and painful to urinate; especially at night several minutes were required to empty the bladder. She neglected to consult a physician until about the middle of April, 1919, when she suffered from a severe hæmorrhage from extra exertion (housecleaning) and a second hæmorrhage the next day. The patient was under observation about 2 weeks. Frequent examinations of urine showed more or less blood.

About May 1, the patient was examined by one of us (C). Diagnosis: tumors of the bladder. Fulguration treatment was given until September. Several slight hæmorrhages and one severe hæmorrhage occurred during this period; then a very severe hæmorrhage made it impossible and unsafe to continue fulguration.

On October 23, the patient was operated upon at the Evanston Hospital. A suprapubic cystotomy was done, the bladder opened, and the tumors exposed. While the larger tumor lay near the right ureteral orifice, it appeared that it could be removed without injuring the ureter. The tumor was caught in a loop of silk, held up, and the base, together with a small area of surrounding mucosa, excised with the cautery. One



Roentgenogram of the bladder taken in the anteroposterior position showing vegetating syphiloma.

Roentgenogram of the bladder taken in the posteroanterior position, showing vegetating syphiloma.

smaller secondary tumor was also removed by the cautery. The bladder was then closed in the usual way with drainage, leaving 50 milligrams of radium on a sound in contact with the site of the tumor. She remained in the hospital 33 days. While there, radium was used five times. The patient returned 2 weeks later for another radium treatment. After that, illness prevented her returning to the hospital, until December 26. Then radium was used once a week for 6 weeks. This makes altogether 12 radium treatments. She received 6 treatments of 600 milligram hours each and 6 of 300 milligram hours each, the radium being screened by 0.5 millimeter of silver and 1.0 millimeter of brass nickel-plated, enclosed in a covering of thin rubber tubing.

CASE 3. Widow, age 70. The previous history shows nothing significant. The patient has had no severe illnesses. Her general health has always been good. For a few weeks prior to the time she was first seen she had had intermittent attacks of hæmaturia. The attacks were of short duration but occasionally lasted several days. The last attack was more marked than the others. She was referred by her family physician, Dr. C T. Roome, to one of us (D) for examination.

Cystoscopy showed the entire bladder slightly reddened, with very slight trabeculation. On the right side of the bladder and outside of the ureteral opening was a papillomatous tumor about one and one-half centimeters in diameter showing a bleeding point in the lower, inner aspect. Both ureteral orifices were normal.

The following day this tumor was fulgurated by one of us (C), fulguration being repeated six times, after which the entire growth disappeared down to the level of the mucosa. On November 29, radium treatment was begun, 50 milligrams being introduced under visual control by means of a cystoscope designed for the introduction of radium, the applicator being left in contact with the side of the tumor for 12 hours. Similar radium treatments were given four times. She then left for Texas, and a report by mail during February indicates that she is still in good health and passing no blood. A report just received from her physician in Texas contains a record of cystoscopic examination showing no recurrence of the growth.

CASE 4. Man, age 41, referred to one of us (C) by Dr. I. A. Port, for hæmaturia. The family history is negative. The patient has always been well except for urethritis at 21 years of age.

Present illness. About 10 years ago, the patient began to have an uneasy feeling in the bladder, which he noticed off and on. About 5 years ago he had attacks of terminal hæmaturia, very little blood appearing at first

Three years ago he had an attack of severe bleeding. At this time he was cystoscoped and a diagnosis of papilloma was made. No treatment was given. Three years passed before another attack occurred. This time there was a severe hæmorrhage, so severe that numerous clots were formed. This obstructed urination and he catheterized himself, causing a severe cystitis. Cystoscopy was performed under scopolamine and morphine and revealed a papillary carcinoma surrounding the left ureteral opening situated internally on the trigone.

Operation. Under general anæsthesia, a suprapubic incision was made and the tumor was burned by diathermy. The usual closure was made. The application of diathermy in this operation was done by Dr. Gustave Kolischer.

The first radium treatment was given 10 days later through the suprapubic wound, the radium being applied for 12 hours. Seven days later radium was again applied. The patient received six radium treatments of 600 milligram hours each and four of 300 milligram hours each, the radium being screened as described above. At the conclusion of this series of irradiations, cystoscopy showed the tumor to be

entirely gone. The patient is now actively engaged in his usual occupation but is to be kept under observation.

CASE 5. Man, age 26, was referred to one of us (C), for cystoscopic examination on account of hæmorrhage. The previous history is negative.

Cystoscopic examination revealed a raspberry-like papillomatous growth just outside of the left ureteral orifice, on the side of the bladder wall. This was fulgurated five times with prompt disappearance. This was 4 years ago. There has been no recurrence. No radium treatment was given.

CASE 6. Woman, age 73, housewife, mother of five children, living and well. The family history is negative. The patient was referred to one of us (C) for cystoscopy on account of severe bladder hæmorrhage.

Examination showed an elderly woman in apparently good health, with marked anæmia The patient stated that up to present time, for a woman of her age, she had enjoyed good health.

Present illness. About one week previously without any premonitory symptoms the patient suddenly had a severe hæmorrhage from the bladder. The blood was terminal and red. Hæmorrhage stopped as suddenly as it came. In a few days this was followed by another attack, but not so severe. Except for a general feeling of lassitude, there were no other symptoms.

Cystoscopic examination showed a typical papilloma situated on the trigone just forward and internal to the right ureteral orifice.

This growth was treated by means of fulguration, ten applications being given. After this radium treatment was given by Dr. Gustave Kolischer. The patient has been perfectly well for 4 years. She is now 77 years of age and her daughter says until the last few weeks she has enjoyed splendid health. At present there is some bladder irritation. Patient refuses further examination.

CASE 7. Widow, age 65. Referred to one of us (D) for hæmaturia.

Previous history. The periods ceased 5 years ago. The patient has had three children, ages 16 to 30, labors normal. She had no illnesses. One year ago she went to a physician, her statement of her reason for doing so being indefinite. She had a laparotomy, the exact nature of which she cannot explain but says that her appendix was removed and "bladder was supported." One year ago she began to have very frequent urination with blood in the urine and the urination later becoming painful. This has continued up to the present. Pain is more severe at times and the urine is frequently very red.

General examination shows a pale, poorly nourished, thin woman. The abdomen is negative except for a median scar. Neither kidney is palpable. Vagina, very marked rectocele, anterior wall thickened, infiltrated and indurated, mobility very greatly decreased. The external meatus is very reddened. The cervix shows a large, bilateral laceration. No other pathology is found; no other discharge. The uterus is anteflexed, of normal size and movable. The urine is very turbid, the microscopic field is crowded with red cells and leucocytes.

Cystoscopic examination, September 12, showed the fundus and lateral walls of the bladder normal. The base of the bladder shows a large area, the center of which is sloughing and bleeding. The edges are raised and have a cauliflower-like appearance. The ureteral orifices could not be seen.

Intensive X-ray treatments were given by the radiologist of the Evanston Hospital, the lower abdomen being mapped off in areas and treated systematically. Subsequently radium was applied inside the bladder by means of a cystoscopic applicator, 50 milligrams being used and allowed to remain from 6 to 12 hours. Five such treatments were given. The hæmorrhage stopped soon after the beginning of X-ray treatments. The patient's general health is improved greatly.

On November 25, the cystoscopic appearance of the mass was very much better, as hæmorrhage had stopped and the growth had decreased in size. After this the patient refused to submit to any cystoscopic examination and only with difficulty could she be induced to allow the application of radium.

HÆMATURIA

While it is not our intention to go extensively into the symptomatology of these growths, we would like to call attention to the fact that every one of our cases first announced its presence by hæmaturia. This agrees with the statement of Kelly and Burnam that the cardinal symptom is hæmorrhage, first at intervals extending perhaps over months, later increasing in amount until in some cases it may become constant and profuse.

It cannot be too strongly emphasized that hæmorrhage from the bladder calls for immediate investigation by means of the cystoscope. Cystoscopy should be done with great care, as careless instrumentation may increase bleeding.

Pyuria is also frequent. A pedunculated tumor which may chance to be situated so that it may fall over the internal urethral orifice may thus cause an intermittent stoppage of urine. An instance of this sort came under the observation of one of us (D) a number of years ago.

Our treatment of the cases herein reported, excluding the luetic growth which has disappeared under specific treatment, has been as follows:

1. Suprapubic cystotomy and cautery excision followed by radium in one case;
2. Fulguration followed by radium in two cases;
3. Suprapubic cystotomy with destruction of tumor by diathermy followed by radium in one case;
4. Fulguration alone in one case.

We would divide the treatment of bladder tumors in the following way:

1. Fulguration through the cystoscope followed by radiotherapy applied through the urethra.
2. Cystotomy and the destruction of the growth by diathermy followed by radium.

Trans-urethral fulguration is particularly applicable to small growths especially if these be non-malignant papillomata. It may be repeated from one to ten times and does not require a prolonged detention in the hospital. Particularly in women, the method is so easy of application that scarcely any discomfort is caused. Care should always be taken that the underlying mucous membrane is not damaged by the fulgurating wire. Fulguration also is of value in treating small recurrences following operation. It was so used in two of the cases reported above.

The larger tumors are better attacked through the suprapubic incision. Extraperitoneal cystotomy is highly safe and is easy of execution and may often be done under gas anæsthesia. The growth may then be destroyed by diathermy, which is simply the application of fulguration on a large scale using a large metal fulgurating point. By this means, the tumor may be destroyed down to the level of the mucosa and more deeply-lying cells and those in the immediate vicinity of the bladder wall may be coagulated, thus rendering less likely secondary implantation or recurrence of the growth.

The credit for first calling attention to the value of this mode of treatment belongs to Kolischer.

We particularly wish to emphasize the value of radium in the treatment of these growths of the bladder. By whatever means we may choose primarily to remove the tumor, it seems to us that it is essential that the operation should be followed by radiation in order to render less likely the recurrence of the growth. This we look upon as a prophylactic measure of high importance.

Radium may be applied through the suprapubic wound upon the end of a flexible sound, which is introduced at the end of operation, the radium being visually placed upon the site from which the tumor has been removed. Later applications, however, must be made either by introducing the radium upon the sound through the suprapubic wound, placing it as nearly as possible in the area of the tumor, or, by introducing it through the urethra upon the sound, attempting also to place it as nearly as possible in contact with the tumor or in contact with the place from which the tumor has been removed.

To overcome the uncertainty in bringing the radium applicator directly in contact with the area it is desired to treat, a cystoscopic applicator modeled after that which has been used by Young has been devised by one of us (C). This applicator makes it possible for the radium to be visually placed in contact with the bladder area which it is desired to treat.

The instrument consists of a sheath to the beak of which a radium applicator may be screwed and through which passes a straight cystoscopic lens system by means of which the movements of the applicator may be observed. Upon the sheath is a sliding ring with a set screw which may be fastened in contact with the external meatus in order that the instrument may not pass further in or slip out after the radium has been applied, as the position of the ring may be observed by the nurse. A metal wing or indicator is also provided at the outer end of the sheath which lies in the same plane as the beak so that by watching the position of this and the ring above alluded to, the radium within the bladder may be kept in the same position for several hours, if desired. After introducing the instrument, we apply a straight drainage tube of metal, which fits the lumen of the instrument accurately. To the end of the metal tube a rubber drainage tube may be attached so that the patient may be kept dry.

This instrument we have used with great satisfaction. The accompanying illustration

shows the appearance of the instrument and mode of application. We have applied 50 milligrams at a time, using a screening of 0.5 millimeter of silver and 1.0 millimeter of brass, covered by thin rubber and have allowed the applicator to remain in contact with the growth from 6 to 12 hours. In a great majority of instances the applications have lasted 12 hours.

One may also radiate bladder tumors rectally or vaginally by placing the desired amount of radium in a Kelly open cystoscope, a portion of the barrel of which has been removed. The closed side may be fortified by sheet lead to protect the rectal or vaginal mucosa, and the whole enveloped in sheet rubber as suggested by Willis, for treatment of malignant growths of the prostate.

It seems as logical and as necessary to follow fulguration of the bladder with radiotherapy as it is to use the X-ray after operating for carcinoma of the breast.

We would urge the importance of making use of this form of treatment after the removal of every neoplasm of the bladder and in view of the indefiniteness of the dividing line between non-malignant papilloma of the bladder and similar growths of a malignant character, we would suggest its advisability after every fulguration for papilloma.

Attention has also been drawn by Kolischer to the disappearance of several tumors after the application of radium to one. This was illustrated in our Case 2. Whether it is caused by a ferment acting through the blood stream developed as a result of the application of radium to the large tumor or on account of the distant effect of the radium-rays we are not able to state.

In conclusion we would emphasize the necessity of remembering that syphilitic growths may very closely simulate carcinoma and that careful observation may be needed to distinguish between them. We also wish particularly to call attention to the value of radiotherapy as an adjunct to operative measures.

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SYPHILOMA VULVÆ[1]

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THE reason that the descriptive term, syphiloma vulvæ, is applied to the disease under consideration, rests on both histological and clinical grounds. Histologically, the hypertrophied masses of the diseased area are gummatous and subject to the familiar necrotic changes and cicatricial contractions seen in gummata. Clinically, the vulvar changes become manifest a long period, some times many years, after the primary infection. Moreover, luetic induration of the vulva is apt to supervene in the absence of all other specific changes after a long interval of apparent health, which accounts in part for the many mistakes in diagnosis which are made.

The old term "esthiomène" (from the Greek word, meaning "to erode"), first applied to the disease by Huguier in 1849, being purely descriptive and, therefore, too general, is advantageously replaced by a name distinctly indicative of the syphilitic origin of this condition, as shown in the title. The costumary misleading nomenclature such as esthiomène, lupus vulvæ, etc., still found in the literature should be abandoned and replaced by syphiloma vulvæ, which term characterizes the disease.

Although in a previous contribution to this subject entitled "Esthiomène and Secondary Elephantiasis Vulvæ," Dr. Heimann and I (18) took the stand that the disease was the expression of a process set afoot by no known specific agent as a direct exciting cause, continued investigations along this line incline me more strongly to the opinion that these changes are always ultimately referable to a specific, i.e. luetic infection. This view is gradually gaining ground in the literature, although some writers still interpret the affection as a primary idiopathic disease; others, more numerous, as a manifestation of tuberculosis and sometimes carcinoma; a few are inclined to attribute it to lymphatic obstruction resulting in a form of pseudo-elephantiasis; and finally, it has been explained as a filth disease, beginning as a purely inflammatory change due to local traumatism or irritation and maintained by neglect and lack of cleanliness. However, incontrovertible testimony is constantly accumulating to the effect that this peculiar and long unrecognized condition represents a tertiary syphiloma of the vulva.

It is noteworthy in this connection that in the *Index Catalogue of the Surgeon General's Office, U. S. Army*, 1915, vol. xx, Second Series, under the heading of "esthiomène," the reader is still referred to lupus and "tuberculosis" of the vulva, an entirely incorrect inference. Still more recently, in the second edition of Graves' *Gynecology*, 1918, p. 229, it is stated that the disease is of obscure origin and does not yield at all to antisyphilitic treatment, although it is thought to have some possible relationship to syphilis. The writer challenges this statement on the ground that syphilis is always responsible for the disease and that specific treatment in combination with operative removal of the hypertrophied tissue is followed by decidedly favorable results, even in those cases where the syphilitic character of the lesion is not demonstrable by the customary tests. Unquestionably an etiological part is occasionally played by malignant disease and by tuberculosis in the production of *similar* vulvar changes, as in a case observed by Sir Malcolm Morris concerning a woman past middle age who, after having been for years subject to lupus of the face, developed the disease in the vulva.

If, on bacteriological examination of specimens, the tubercle bacillus is found, the case is one of lupus pure and simple and is not related in any way to the disease under consideration. Primary malignant disease of the vulva in the form of epithelioma is of very rare occurrence and of more rapid growth than syphiloma, as I have shown in a previous paper[2] on "Primary Carcinoma of the Vulva."

[2] Stein, A. Am. J. Obst., 1916, vol. lxxiv.

Thesis submitted to the American Association of Obstetricians and Gynecologists for admission to active fellowship.

Its manifestations are not likely to be confused with the deep-seated subcutaneous nodules of a syphiloma situated between or upon the labia. As was recently pointed out by Thorn (21), syphilis may exactly simulate cancer in any location, either of the viscera or on the surface of the body. The microscopical findings, however, will definitely establish the existence of malignant disease.

The great majority of vulvar indurations, including those in which no tubercular or malignant origin is demonstrable, should in future be charged to syphilis and a suitable descriptive terminology be adopted. The names of tertiary vulvar syphilide, syphilitic ulcerative induration of the vulva, or syphiloma vulvæ, are in conformity with recent additions to our knowledge of this disease, which has puzzled several generations of investigators, although it was long ago recognized and described by Fournier (6) as well as by a number of German writers and by J. N. Hyde (12) and R. W. Taylor (20) in this country.

Prior to the publication of Huguier (10 and 11), in 1849, who pronounced the disease to be a form of tuberculosis, emphasizing the similarity of diseases of the vulvo-anal region with those of the face, a view which has ever since persisted and recurred in the literature, certain cases of so-called vulvar esthiomène had been correctly referred to syphilis, although cancer and elephantiasis were also regarded as responsible for the proliferation by the old writers. (The term elephantiasis vulvæ as applied to these cases is wrong. It should be named pseudo-elephantiasis, a condition which simulates true elephantiasis, a disease of an altogether different etiology.)

The great French writer on syphilis, A. Fournier, whose clinical knowledge of that disease far surpassed not only that of his contemporaries but also that of writers of a much later date, gave an excellent description, in 1873, of this vulvar syphiloma which he depicted as [1] "composed of uniform, smooth, slightly protuberant surface lesions, pinkish or reddish in color, dry, and covered with a slight desquamation." He emphasized that these "surface lesions are not the result of fusion of several neighboring papules but are originally formed by a papular neoplasm spreading over a large surface. The changes are of variable extent, sometimes occupying only one of the labia majora entirely or in part, or both labia majora may be involved together. Frequently the lesions encroach on the neighboring regions, on the genito-urinary folds, the perineum, the thighs and the mons veneris." It is noteworthy, he said, that they determine not only a considerable swelling of the affected parts but also invest these parts with a very peculiar resistence and elasticity. A diseased labium majus for example is not only increased in size but both hypertrophied and indurated. Digital examination reveals a specific dry hardness without œdema which does not yield to pressure but is resistent like sclerema. In Fournier's graphic account, the affected labium is described as "apparently lined with parchment," and the sensation experienced on touching the tumor is altogether unique.

Fournier's diffuse hypertrophic syphiloma of the vulva is commented upon as follows by Abraham (1) in *A System of Syphilis*, published in 1914: "This consists in a massive infiltration of one or more parts of the vulva which may become generalized over the whole of its extent. This infiltration is of a stony hardness and may alter entirely the conformation of the parts so as to make the original structure absolutely unrecognizable." The enormous tissue destruction which is a pathognomonic feature of lues is the result of preponderance of the necrotic process over the tendency to fibrosis and contraction of scar tissue. Moreover, the peculiar combination of hypertrophy and ulceration is plainly indicative of lues.

Syphilis was recognized as the most probable causative factor by Grace Peckham (16) who, in 1887, published a tabulated analysis of 33 cases, 7 of which had a definite history and 19 a probable history of syphilis. This high percentage would undoubtedly have been still further augmented by modern diagnostic methods for the recognition of lues.

[1] The above translations carefully follow the originals and are given here because these lines although written nearly fifty years ago perfectly describe the disease loosely known as vulvar esthiomène and still ascribed to a variety of other causes.

James Nevins Hyde (12), writing in 1889, was like Fournier, a pioneer whose insight into the causes underlying this disease was too far ahead of the standard of his contemporaries to find ready acceptance. At that time he called attention to the clinical fact that a woman with a gummatous lesion of the vulva may not only betray no other symptoms of syphilis but may exhibit all the other evidences of sound health. In his experience women were far more frequently than men the bearers of isolated syphilitic lesions.

It may be noted here that it requires special training to recognize syphilis in a single symptom. Furthermore, this lesion does not conform to the common preconceptions relative to other genital manifestations of syphilis. Not only is the syphiloma of far rarer occurrence but it also does not in external features and career resemble chancres and so-called secondary lesions of syphilis having a vulvar site.

In 1890, R. W. Taylor (20), in a very complete and elaborately illustrated contribution to the subject, described some illustrative examples of luetic deformities of these parts, namely the various forms of hypertrophy induced by the indurating œdema of syphilis; hyperplasia resulting from chronic ulcers; the so-called chancroids in intermediary and old syphilis; hyperplasia in old syphilitics presenting no specific character and occurring soon or long after the period of gummatous infiltration, in some cases being co-existent with specific lesions which are present elsewhere in the body.

Scattered through the older literature illustrative cases may be found showing an endeavor to make syphilis the responsible factor in these cases. For example, Boulton (2), in 1883, operated upon a case reported by him as one of extensive syphilitic disease of the vulva with a gummatous hyperplasia of the clitoris. He removed the hypertrophic clitoris with the cautery and administered potassium iodide internally with very favorable results. The findings on examination are graphically described as a bifurcated mass the size of a double fist consisting of hypertrophic clitoris and nymphæ hanging down in front. Goucher and Nathan (8), in 1908, reported a case of chancriform syphilide of the vulva in a woman of 45 years whose left labium majus was enormously enlarged and covered with papular syphilides. The swelling subsided as a result of iodide injections.

Six illustrative observations on patients between 22 and 58 years of age suffering from tertiary syphilis of the vulva were reported by Lena Kurz (13), in 1913, who correctly designates the disease as a tertiary manifestation of syphilis but unfortunately still clings to the objectionable term of esthiomène or lupus vulvæ.

R. Vignolo (23), in 1914, reported a case of tertiary anorectal and vulvar syphiloma in a patient of 30 years who before coming under his observation had been treated elsewhere for some time for vaginal affection which was diagnosed as "esthiomène" and treated with repeated cauterizations. Her general condition became steadily worse and she was finally admitted to a surgical clinic where the diagnosis of carcinoma of the rectum was made and operation recommended. When seen by Vignolo-Lutati in the Turin clinic he made the diagnosis of syphilis although the Wassermann test was negative, and specific treatment was instituted in the form of one to two weekly injections of calomel, gr. 5. Within 2 months remarkable improvement was obtained both as regards the general condition and the local findings. The therapeutic effect thus confirmed the assumption of a tertiary recto-anovulvar syphiloma in this highly instructive case. The observer pointed out that the etiological diagnosis confirmed by the treatment was especially important on account of the coincidence of tertiary anorectal and vulvar lesions.

Four cases of syphilitic induration of the vulva in young colored women were very recently reported by Gallagher (7), who on the basis of his observations concludes that a radical removal of the growth with complete and thorough cauterization of the ulcerated areas and intensive antisyphilitic medication will effect a cure in these cases. My own experience has led me to the same conclusion.

ETIOLOGY

This disease is always due to syphilis even in those rare cases in which the relationship cannot be positively established. Histological data in the majority of the cases afford conclusive evidence as to the specific character of the changes. When syphilis is not demonstrable, the disease must be considered as indirectly due to syphilis, having developed in an infected individual on a soil prepared and altered by syphilis. As modern methods of investigation improve, it will be found that the number of cases will continually increase in which positive signs of luetic infection will be found.

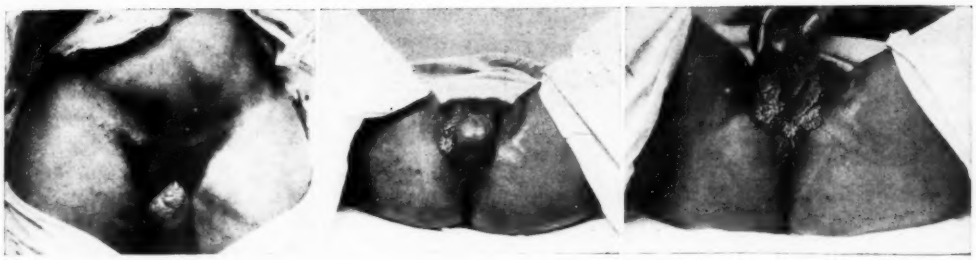
DEFINITION OF LESIONS

The lesion is a slowly progressive indurated tumor, causing no pain and giving rise to inconvenience only through its cumbersome size. The swollen and indurated vulvar regions usually are the site of deep seated ulcers which show no predilection for any particular part. This tertiary manifestation of syphilis in no way lends itself to confusion with the primary lesion on the genitals but constitutes a well defined pathological picture confirmed by the microscopical findings which plainly reveal the familiar features of gummata (syphilomata).

The point of origin of vulvar syphiloma varies greatly although three regions are especially susceptible, being in order of frequency the fourchette, the urethra, and the rectum. In certain rare cases the genital zone is at first free from all changes, the sclerematous lesions beginning with a low rectal or anal stricture and spreading to the genital organs through the rectovaginal wall. As a rule the labia minora and the clitoris are involved in the ulcerative and hypertrophic process and sometimes the entire vulva is deformed and altered in outline. This constant combination of hypertrophy and ulceration is characteristic of syphilis.

In order to present the subject matter as clearly and concisely as possible, the description of the changes noted in syphiloma vulvæ has been arranged under the separate headings of microscopical, gross, and clinical pathology as follows:

Microscopical characteristics of syphiloma. Histologically, a syphiloma consists of a collection of round cells closely resembling the cells derived from inflammatory neoplasms with scanty blood-vessels. The affected tissues, like all gummata, undergo processes of necrosis and cicatrization with contraction of scar tissue. According to Lubarsch (14) gummatous nodules are microscopically interpreted as granulating inflammatory products which are especially rich in lymphocytes and frequently show fibroblasts and fibrillary tissue. The products pass either into solid connective tissue or undergo necrosis in the area of the cellular as well as fibrous portions, the original general tissue structure often remaining recognizable in the form of fibrous strands, traces of blood-vessels, and cells without nuclei. Whereas small syphilomata in their earliest stages resemble condylomata and contain chiefly small inflammatory cells as well as plasma cells, those which have attained a large size possess a more variegated structure containing plasma cells and epithelioid cells besides small round cells of lymphocyte type and presenting diffuse extensive caseation often surrounded by small nodules containing epithelioid and giant cells. These structures are liable to be confused with those of tuberculosis, the following features being of value for the differential diagnosis: In syphiloma the epithelioid cells are usually less numerous than the small granulation cells and plasma cells. Fibroblasts and fibrillar connective tissue are apt to be conspicuously represented in syphiloma but are only exceptionally demonstrable in tubercles. Caseation is more extensive as a rule in syphilomata than in tubercles and in the former occurs in the stage of connective-tissue transformation, whereas in tubercles caseation invariably precedes this change. As a result a caseated syphilitic focus usually still contains demonstrable tissue elements, whereas a caseated tubercle forms an amorphous mass. In a general way the diseased tissue presents hypertrophic and inflammatory changes. The microscope shows an accumulation of embryonic cells in the middle layer of the dermis arranged around the blood-vessels and progressively diminishing in frequency at a



Figs. 1, 2, and 3. Case 1. Syphiloma of the vulva.

distance from the vessel. The lymphatics are dilated and packed with endothelial cells. The subdermic tissue likewise contains a large quantity of dilated vessels. These lesions terminate in the formation of scar tissue and sclerosis.

Gross and clinical pathology. It is a noteworthy fact that the affected parts present an entirely different aspect in the living and in the dead subject. After death the vulvar protuberances lose their turgescence, the perineal elevations and projections become flattened and lose their semi-erectile character. The induration and hypertrophy of the vulvar and perivulvar tissue disappear almost entirely. The protuberances become softened, flabby, and wrinkled. In the living subject the color of the affected region is apt to be reddish or purplish in youthful subjects; dull gray or livid in older women. The tegumentary covering of an infected labium majus usually presents a purplish color, the mucous membrane is often dusky red, and the abnormal coloration frequently extends to the adjacent labium minus.

A fully developed syphiloma of the vulva appears as a more or less symmetrical enlargement of the labia majora on both sides, so that the shape of the tumor thus formed was compared by Hyde to that of a horse collar. The clitoris above is enlarged and sometimes represented by one or more soft or solid projections. The labia majora are much enlarged as a whole, fibrous and thickened, furrowed, ridged or the seat of fungosities. In some cases they have been found to contain very hard tumors the size of a marble. The labia minora are changed and deformed, not infrequently the seat of ulceration at their internal aspect and free borders. The vestibule region is greatly thickened, superficially or deeply ulcerated, either diffusely infiltrated or interspersed with circumscribed nodules. These vulvar ulcers have very irregular edges and discharge a scanty and at times purulent secretion.

The luetic process may extend to the perineum and anus manifesting itself in the form of large or small fleshy masses and excrescences. In the second case under my own observations the labial ulceration encircled the introitus vaginæ and extended for some distance into the vagina. Hyde refers to a case in which the vagina and rectum were converted into a wide chasm bridged by a few persistent strands of vulvar or vaginal connective tissue.

Syphilomata, here as elsewhere in the body, may heal, leaving deep, radiating, and adherent cicatrices but are more apt to give rise to destructive ulceration especially in the vulvovagino-anal region. This behavior can be explained by the existing circulatory disturbances due to a primary change of the efferent lymphatics and regional blood-vessels through the syphilitic infection.

Clinically the disease is essentially characterized by its painlessness, non-interference with the patient's general health and disproportion between the local changes, and the resulting disturbances. The affected parts are not abnormally hot. There is no itching, as a rule no tenderness or pressure and no evidence of acute congestion. Until the condition has become complicated by ulceration of the vestibule with more or less in-

Fig. 4. Photomicrograph of specimen, Case 1.

vasion of the urethral orifice and urethra causing painful micturition or by perineal infiltration with anorectal involvement resulting in painful, sometimes bloody, stools, the patients, as shown by my personal observations, and the cases recently reported by Gallagher and numerous others scattered through the literature, are remarkably free from pain or other subjective symptoms.

TREATMENT

As shown by my personal findings and the above quoted observations of other writers the treatment of syphiloma vulvæ is both surgical and medical. Operative interference consists of excision and destructive cauterization of all tumors and excrescences. This radical procedure is usually effective and not followed by a recurrence of the condition. Intravenous injections of salvarsan are an essential supplement of the surgical treatment. The prognosis is very favorable as is to be expected in properly treated gummatous changes of tertiary syphilis.

The following two cases came under my observation at Harlem Hospital, New York City (Service of Dr. I. Haynes), where they were treated simultaneously (Histories Nos. 639 and 691):

CASE 1. L. V., colored, single, age 20 years; admitted to the hospital May 5, 1919. The family history as well as previous personal history is negative. Menstrual periods began at 13 years, occur regularly every 28 days, and last 3 days. She has had no miscarriages and no confinements.

Present history. About a year ago the patient noticed a small swelling at her outer genitals. This swelling increased steadily in size and 3 months previous to her admission to the hospital she noticed that ulcers were forming in the swelling. These ulcers although absolutely painless gradually became more extensive and severe taking on a very offensive odor. The patient has also noted of late the development of a rather large tumor which hangs from the outer genitals between the thighs.

General examination. The patient is a well developed woman in good general condition. The abdomen is negative. The skin, lips, mouth, throat, and glands all fail to show any signs of luetic infection.

Local examination. Due to the fact that internal examination is very painful to the patient, it is done under anæsthetic with the following findings: Introitus vaginæ scarred and unyielding and the whole surrounding tissue infiltrated. Vagina admits two fingers. The greater part of the hymen is destroyed. There is a large ulcer on the lower third of the posterior vaginal wall. This ulcer is hard in consistency and shows infiltrated walls covered with a dirty purulent matter. The uterus and adnexa are found to be perfectly normal.

The general appearance of the vulva is as follows (see Figures 1, 2, and 3): The affection of the outer genitals can be divided into two parts, namely one large tumor originating in the right labium minus and two marked indurative processes affecting both labia majora. The tumor of the right labium minus measures three and a quarter inches from pedicle to its top, two and a half inches in depth and three inches in width. This tumor is extremely hard and shows normal skin on its outer surface whereas on its lower surface near the pedicle it presents deeply ulcerated areas. The left labium minus is very hard, parchment-like, sausage-shaped, nearly two inches long, indurated but showing no ulcerative areas.

The right labium majus is transformed into a sausage-shaped mass three and a half inches long.

The lower portion comprising about two-thirds of the entire labium is markedly indurated and ulcerated. The left labium majus is similarly affected with marked ulceration also present, although in a somewhat lesser degree.

This indurative process occupies also the entire perineum extending down as far as the anus and showing several condylomata-like growths.

Rectal examination shows the anus and rectum to be free from any indurative process.

Blood examination: polymorphonuclear 72 per cent, lymphocytes 28 per cent, white blood cells 8,700, red blood cells nearly 6,000,000, hæmoglobin 90 per cent.

Wassermann test, May 10, 3+; May 12, 4+.

Diagnosis: syphiloma vulvæ (œdematous, indurative, ulcerative, syphilitic tumor of the vulva).

Treatment. The pedicle with tumor of right labium minus was removed and the stump was ligated with double chromcatgut. The wound was properly cauterized. There was no bleeding. A large lemon-shaped piece from the right labium majus comprising the indurated areas as well as the ulcerative mass was then excised. Spurting vessels which were rather numerous were ligated and the skin sutured over wound with numerous chromic catgut sutures reinforced with silk-worm sutures.

Exactly the same procedure was followed in regard to the left labium majus only that the area excised was smaller. Before closing the skin the wounds on both sides were thoroughly cauterized.

The excised parts were sent to the laboratory of the Hospital for examination and I am greatly indebted to Dr. Elise L'Esperance, director of the laboratory, for the report on this case as well as the next.

Laboratory report. Specimen consists of (1) a portion of the right labium majus, (2) a portion of the left labium majus, (3) a tumor mass from the left labium minus.

No. 1, specimen from the right labium majus, shows an area of skin and subcutaneous tissue measuring 6½ by 4½ centimeters. Occupying about 4 by 3 centimeters of this portion of the labium is a deep, punched-out ulcer with hard, densely indurated irregular edges and a base covered with grayish necrotic material. On cross section the indurated white area is seen to extend from the base of the ulcer for a considerable distance into the subcutaneous tissue of the labia.

Microscopical examination reveals an area of thickened epithelium and an œdematous subcutaneous tissue at the edge of an ulcer. The ulcer shows superficial erosion with exudate of serum, fibrin, and polynuclear leucocytes. The base of granulation tissue extends through to the subcutaneous tissue and approximates a wide zone of round-cell infiltration consisting of many plasma cells and lymphocytes. This infiltration radiates in strands into the deeper tissues and is associated with marked perivascular infiltration (Figs. 4 and 5).

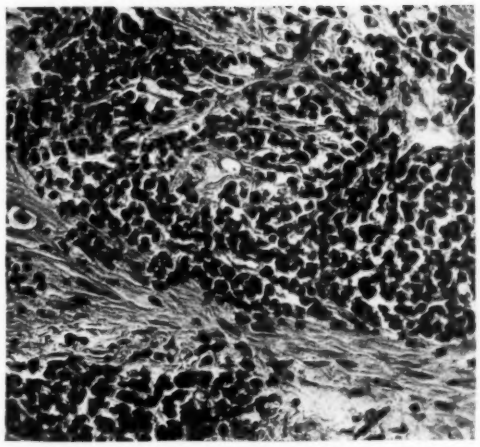


Fig. 5. High power photomicrograph of specimen, Case 1.

No. 2, the specimen from the left labium majus, shows an ulcer 3½ by 2 centimeters with the gross characteristics of the one encountered on the right labium. The ulcer is deeper and the induration more marked. Microscopical section reveals an histology almost identical with the ulcer on the right labium with the exception that the perivascular infiltration is more extensive.

No. 3, specimen of tumor, an oval mass 9 by 6¾ centimeters, somewhat firm, covered by thickened, dark integument. On cross section the entire area suggests œdematous, subcutaneous tissue with a firm covering of skin. Microscopical section reveals an intact layer of epithelium beneath which the loose acellular subcutaneous tissue shows pale-staining and œdematous.

Sections of these three areas having been stained by the Levaditi method, a careful search fails to reveal spirochætæ. The location of the ulcers, the indolent nature and extensive round-cell and plasma-cell infiltration arranged in strands, associated with definite perivascular character, give strong evidence of the syphilitic nature of these lesions.

Diagnosis: Syphilitic ulcers of the labia majora. Marked subcutaneous œdema of the labia minora.

During the weeks of her convalescence the patient received bi-weekly intravenous injections of salvarsan, gram 0.6, and the affected areas showed prompt improvement with rapid healing of the wound.

The patient left the hospital before we were ready to discharge her. She returned 3 months later, however, with a new-growth, similar to that described above and affecting that part of the labia which had not been entirely removed. This second growth was removed by operation and the patient was subjected to drastic antisyphilitic treatment

Figs. 6 and 7. Case 2. Syphiloma of the vulva.

but as before, she left the hospital without being completely cured.

CASE 2. J. C., colored, married, age 22 years; admitted to the hospital May 19, 1919.

The family history as well as previous personal history is negative. Menstruation began at 13 years of age, is regular every 28 days, and lasts 4 days. Last period May 11. No miscarriages. One normal confinement.

Present history. The patient states that a painless growth started in the vulvar region about 2 years ago and that this growth has gradually become larger and larger, never causing any pain however, except for an occasional burning sensation on urination. Upon further examination the patient admits that several years ago her husband contracted a "cold" of the genital organs.

General examination. Her general appearance is that of a healthy, well nourished woman. Abdomen negative. Lips, mouth, and throat negative for signs of luetic infection. No glands are palpable.

Examination of blood shows normal conditions.

Wassermann test, May 20, 2+.

Local examination. The right labium minus is transformed into a hard, indurated tumor about the size of a lemon. The tumor involves the entire right labium minus. The left labium minus shows a similar tumor of the same make-up but somewhat smaller. Upon pushing the two tumors upward toward the abdomen an ulcerative area involving the entire lower surface of both tumors as well as that of the clitoris is seen. The latter seems to be entirely absorbed in the ulcerative area (Figs. 6 and 7).

The labia majora are somewhat indurated although not to any such extent as in the first described case. The perineum, however, has been entirely dissolved by the ulcerative process, resembling in its tissue defect a perineal tear of the third degree. The surrounding tissue in the lower third of the posterior vaginal wall is hard, indurated, and covered with confluent ulcers of a dirty, grayish-yellow surface. The wall of the rectum is not involved. All of the above described ulcers are of exactly the same type, namely indurated with ragged undermined edges and bases covered by a dirty, grayish necrotic membrane.

Diagnosis: Syphiloma vulvæ (syphilitic, indurative, ulcerative, œdematous tumors of both labia minora and deep syphilitic ulcers of lower third of vagina with destruction of practically the entire perineum).

Operation, May 28, 1919. The pedicles of both tumors of the labia minora were clamped off, burned off with cautery, and stumps securely ligated with double chromic catgut. The ulcerated area of the lower part of the vagina was then also extensively cauterized and the vagina tightly packed with iodoform gauze.

This patient also received bi-weekly intravenous injections of salvarsan, 0.6 gram, during her convalescence with marked improvement in the local conditions.

The laboratory report was practically identical with that of the first case.

Laboratory report. Specimen consists of (1) portion of right labia and (2) scrapings from ulcers in the vagina.

No. 1. Specimen consists of an area from the right labium majus measuring 5½ by 4 centimeters in the distal portion of which there is an indurated ulcer 3 by 1 centimeters, with ragged undermined edges and base covered by a grayish necrotic membrane. Histological examination reveals a superficial erosion of the epithelium with underlying round-cell infiltration which shows a tendency to radiate from the original focus. There is moderate perivascular infiltration which extends for a considerable distance under the normal epithelium.

No. 2. The small bits of material from the vaginal ulcers have no definite gross characters. Microscopical examination reveals a deep erosion with complete destruction of squamous epithelium associated with marked round-cell and plasma-cell infiltration. Their location and indolent course appear to warrant the diagnosis of syphilitic lesions of the labia and vagina.

Material from the labia and vagina stained by the Levaditi method failed to reveal spirochætæ in the tissues.

CONCLUSIONS

1. In conformity with modern knowledge and in the interest of a better understanding of the disease, all misleading names such as esthiomène or lupus vulvæ should be exterminated from the literature.

2. Syphiloma vulvæ correctly designates the disease as a manifestation of tertiary lues.

3. A positive Wassermann test is not essential in view of the long standing character of the specific infection in the majority of the cases.

4. The treatment under all circumstances should consist of (1) operative removal of all tumors, hypertrophied tissues and ulcers, followed in the same session by (2) energetic cauterization and combined with (3) intensive antisyphilitic medication.

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THE EFFECTS OF RADIUM EMANATIONS UPON BRAIN TUMORS[1]

By CHARLES H. FRAZIER, M.D., D.Sc., F.A.C.S., Philadelphia

MALIGNANT tumors of the brain differ from malignant tumors of other organs and structures in ways that are quite striking. Notable, as a differentiating feature, is the absence of metastasis. No matter how long its duration, a malignant lesion of the brain never metastasizes to other organs. This curious feature of the life history of brain tumors is not easy to explain.

Secondly, unlike that of malignant tumors elsewhere, the growth of malignant tumors of the brain is in many instances surprisingly slow. The rate of growth varies, no doubt, according to the character of the growth; thus the life history of the endothelioma is longer than that of the glioma, but even in the latter there is reason to believe from the history that 4 or 5 years may have elapsed before the patient is sufficiently disturbed to consult the surgeon and with the endothelioma, the history may cover a period of 10 years or longer. Only recently I uncovered a tumor in a patient who had had focal symptoms (Jacksonian seizures) 10 years before she began to suffer from headache and visual disturbances.

A third distinguishing feature of brain tumors is this: that the cardinal symptoms, headache, vomiting, and disturbances of vision, are attributable often not to the presence of the tumor but to the secondary ventricular distention. The tumor often is not the immediate cause of death, nor for the distress that usually precedes it; whereas in malignant growths of other organs, death is due to the more or less widespread metastasis and the resultant cachexia and anæmia.

A fourth distinction and a very practical one, is the inaccessibility of the growth on the one hand or the absence of localizing signs on the other. An exploratory operation for an obscure tumor of the abdomen will invariably discover the seat and nature of the growth. The exploratory craniotomy will often fail to reveal the growth if it be subcortical and without clearly localizing signs.

Finally there are conditions, peculiar to the brain, which make radical operations prohibitive in any but those tumors that are distinctly encapsulated. The large infiltrating glioma, without definition perceptible to the naked eye, is not a surgical lesion and we must be content with the temporary measure of relief which palliative procedure may offer.

Because the rate of growth is surprisingly slow, because brain tumors are often inaccessible or unlocalizable, because they do not metastasize but continue until the end confined to the original focus, because they are often not directly but only indirectly responsible for the subject's death, because technical difficulties interfere with their radical removal, there is a field for some physical agency, which will not only arrest the growth of the malignant lesion, but even lead to a process of retrogression. It was with this thought in mind that in 1914 I secured by gift for the University Hospital 125 milligrams of radium and deposited it in the care and at the disposal of Dr. Henry K. Pancoast. Since that time, radium has been applied in my clinic under the direction of Dr. Pancoast in the treatment of brain tumors in 24 cases, and from these I have selected 3 cases as illustrations of what radium may accomplish. In these there seems to be indisputable evidence that by radium emanations the growth of the tumor has been arrested and in all probability the tumor destroyed.

For the sake of brevity, the cases are presented in abstract.

Case 1. In 1914, an inoperable tumor of the pontile angle was found at operation. At the time the patient was stuporous and totally incapacitated. Eight-five milligrams of radium were implanted in tumor for 15 hours. Six weeks later improvement was first noted; 4 months later the patient was ambulant. Six years after the first treatment the patient is living, and while symptoms of cerebellar disturbance have not disappeared, the condition is now stationary.

W. R., age 13. File No. 27808, admitted to University Hospital June 18, 1914. The patient had

[1]Presented at the meeting of the International Surgical Society, Paris, July 18, 1920.

been ill for 2 years. Clinical examination showed the following: nausea, vomiting, occipital headaches, vertigo; staggering gait, inclining to right; station disturbed, falls backward and to right; ataxia in movements of arms, both right and left; involvement of fifth and seventh cranial nerves; vision of right eye 6/15 plus 2 diopters, postpapillitic atrophy; left eye 6/9 plus 2 diopters, postpapillitic atrophy; Barany test suggests lesion of vermis.

Operative record. June 27, 1914, suboccipital decompression; August 17, 1914, subtemporal decompression; August 25, 1914, ventricular puncture through corpus callosum; September 23, 1914, suboccipital exploration under local anæsthesia, large inoperable tumor in pontile angle. Eighty-five milligrams radium buried in growth for 15 hours.

Subsequent clinical notes. The patient was discharged October 3, 1914. The stupor which had been present before the operation continued and upon the patient's discharge 10 days after the operation his condition was regarded as hopeless. Improvement was first noted 6 weeks after operation. By January, 1915, he could go up and down stairs and walk without assistance.

April 21, 1915. No staggering, no ataxia, patella reflexes sluggish, no headache, no vomiting.

February 23, 1917. Since last report there have been signs of recurrence; ataxia left arm and leg; marked asynergia of left arm and leg; station not good, wavers to left and in walking sways to left; some impairment of hearing on both sides; total loss of vision. Second treatment with radium emanations.

Final note. Report from patient's mother, June 13, 1920, 6 years after first treatment and 3 years after the second, states that the patient is in excellent health, although there are still evidences of disturbance of equilibrium.

It is perhaps too soon to make a final report on this case. There is no doubt that the effect of the first treatment was very extraordinary. The patient was *in extremis* and it was not thought he would survive more than a few days or weeks at the most. The tumor was of large dimensions, with ample exposure on the operating table but quite inoperable. That the patient should have been transformed from a bedridden and stuporous condition to an ambulant state would seem to admit of but one interpretation. That there is evidence still of disturbance of cerebellar function may be accounted for on the grounds of permanent damage to the cerebellar tissue by the growth before the treatment was begun. This view is further substantiated by the fact that since the second application the condition appears to be stationary.

CASE 2. Child with evidences of serious disturbances of cerebellar function, chiefly left. Unable to stand or sit, difficulty in talking and swallowing, marked adiadokokinesis, hypermetry, vertigo, headache, nausea and vomiting. Postpapillitic atrophy. Following suboccipital decompression and serial application of radium there was an extraordinary improvement in every particular so that 8 years after first observation the child has been restored to almost perfect health.

E. S. age 10, File No. 25492, admitted to University Hospital, December 9, 1913. The patient had been ill 1 year. Clinical examination showed the following clinical findings: nausea, head-ache and vomiting; staggering gait, unable to walk without assistance; paralysis lower part of face (left); difficulty in swallowing; hypermetry and adiadokokinesis in both extremities, left more than right; vertigo; tinnitus; vision of right eye 6/40 postpapillitic atrophy; no swelling; left eye 6/70 postpapillitic atrophy; no swelling; nystagmus.

Clinical diagnosis. Cerebellar tumor—left.

Operation. Suboccipital craniectomy, December 10, 1913. Tremendous pressure. The left cerebellar hemisphere almost entirely herniated through the opening when the flap was reflected. The tumor was not exposed at operation.

Readmission to University Hospital February 8, 1915, at which time the patient showed marked improvement. The headaches, vomiting and tinnitus have subsided. From a state of listlessness and apathy she is now mentally alert, wide awake, active, and talks without difficulty. She can sit erect and walk with but little assistance. Vision is improved, and she can read a newspaper. Vision of right eye, 6/15, formerly 6/40; left eye, 6/15, formerly 6/70; a second application of radium was given.

Readmitted to University Hospital, June 7, 1915. The ataxia was less marked; but little hypermetry. The gait was much improved. The patient can walk about the house without assistance. She carries her head more erect.

A third application of radium was given.

Readmitted to University Hospital, April 30, 1916 and showed continued improvement. She can now sew and can play on the piano. She experiences vertigo only on sudden change of position; there is no nystagmus, and only slight adiadokokinesis in left arm.

A fourth application of radium was given.

Final report. Dr. Homer E. Smith, the physician in charge, reports as follows, June 15, 1920:

"The symptoms of her cerebellar ataxia have nearly disappeared. She can walk without assistance, and with little uncertainty in her gait. She plays with other children and takes part in their outdoor games. The right eye shows a pale disc but her vision equals 8/10 plus. In the left eye (which is divergent), there is a marked atrophy of the optic nerve and vision only 1/10. She goes to school and keeps up in her studies with other children. The inference is that there has been at

least an arrest of the disease and what remains is the expression of the damage already accomplished before she came under your care."

The outcome in this case has been more striking than in Case 1, in that vision has been conserved at least in one eye and the residual signs of cerebellar disturbance are but trifling as compared with the original state. There is, however, in this case a link of evidence missing in that the tumor was not exposed on the operating table. However, the clinical picture would seem to admit of but one interpretation. Viewing the case in the light of a therapeutic achievement, the results 7 years after the first treatment have been, to say the least, extraordinarily gratifying.

CASE 3. Recurrence of headaches and visual disturbances 19 months after a sella decompression. Following a course of glandular feeding, X-ray and radium therapy there was a disappearance of scotomata, restoration of normal vision and re-establishment of menstruation. There was no recurrence 3 years after treatment was instituted.

Female, age 30, consulted me November 27, 1917. Nineteen months before she had been operated upon (sella decompression) in another clinic for disturbances of vision due to an intrasellar pituitary lesion (struma).

Clinical examination disclosed the following: amenorrhœa had been present for 3 years, and still persists; aggravation of headaches; ocular disturbances, right eye, vision 6/6, left eye vision 6/9; scotoma in both right and left eyes.

Treatment. Radium and X-ray therapy; thyroid and pituitary feeding.

Final observation June 1920. Headaches are not so severe, menstruation has been established after cessation of 6 years. Scotomata in both eyes have entirely disappeared. Vision is normal.

The return of normal vision and the abatement of one of the evidences of pituitary disturbance—amenorrhœa—were the two striking results of treatment in this case. Either of them would have been sufficient to convince one that the structure of the pituitary had been decisively influenced; otherwise (after the relapse, which followed a year after the operation), vision would not have been restored nor menstruation re-established. There is to be considered in this case, however, the fact that both radium and X-rays were used and to each must be accredited a share in the results. So far as I know this is the first case in which the radium was applied to the pituitary body, as Dr. Pfahler directed, through the posterior nares.

It seems to me we have learned from this case a very practical lesson in the treatment of pituitary disorders. Sellar decompressions, we know, are often followed by most gratifying and very prompt restoration of vision. Often within a few hours of the operation the patient realizes his sight is better. But pituitary lesions cannot be dealt with radically and we have had in the past no safeguard against recurrence. Secondary attempts to reach the sella, via the transsphenoidal route, are either difficult or impossible. Hence it is a matter of really great significance that we have some means of treating recurrences, once developed, and in the same agency, one would suppose, a means of preventing recurrences. So I count this case worthy of record as marking a distinct advance in the therapeutics of pituitary disorders.

GENERAL REMARKS

I present these 3 cases to the medical profession in the hope that others may be encouraged to continue this clinical investigation. The subject is still in the developmental stage, there is much still to be learned in technique. At the present time, both Dr. Pancoast and I advocate direct implantation in the growth when feasible, rather than more indirect or distant application. The matter of dosage as expressed in milligrams or hours has been in the empirical stage. We have in the research of Williamson, Brown and Butler (SURGERY, GYNECOLOGY AND OBSTETRICS, this issue, page 239) the first really helpful bit of information that may be applied to the technique. We have not known what the effect of radium emanations is on normal brain tissue. These investigations now tell us just what may be expected when 50 milligrams of radium is applied 6, 12, or 18 hours, upon a normal cortex. This research, in which I have a personal interest, must be continued to include larger dosage and longer hours of application. The field must be extended to include the spinal cord. We want to know more about the penetrating effect of the γ-rays through both tumor and normal brain cells

before we can formulate a technique which has a foundation based on facts and not on empiricism.

In closing I should say that in the 24 cases of brain tumor in the treatment of which radium has been employed, I have not yet seen a single case, known to be a glioma, where radium has had any appreciable effect. The endothelioma is unquestionably more susceptible and hence offers the more favorable prognosis.

My purpose in this brief note is to call attention to the possible achievements of radium emanations in a field that offers many opportunities. I must speak very guardedly in order not to be misleading. I offer in evidence three cases of brain tumor where the growth of the tumor, in the light of the clinical evidence, has been arrested at least, the tumor possibly destroyed, in periods of observation covering a maximum of eight years.

A STUDY OF THE EFFECTS OF RADIUM ON NORMAL BRAIN TISSUE

A Preliminary Report

By C. S. WILLIAMSON, A.B., M.D.; R. O. BROWN, M.D.; and J. W. BUTLER, M.D., Philadelphia

RADIUM is now recognized as an effective agent in the treatment of certain neoplasms. It is peculiarly adapted to application in cavities where it can be brought into direct contact with tissues. It is now also being extensively employed to advantage by implantation in neoplasms. Very frequently brain tumors are exposed by operative procedure and excision of the growths is found impossible or inadvisable and in such instances the implantation of radium is very desirable. This has frequently been done but without information as to the dosage that may safely be employed without unnecessarily injuring the normal brain structure. Experience teaches us the probable dosage necessary to destroy the tumor, but we have frequently not known whether such dosage could be employed with safety. The range of safety to surrounding tissue is even more important in connection with the brain than in the case of the structures that may be injured irreparably in the treatment of uterine carcinoma.

With the idea of determining, as accurately as possible, the safe dosage, the radius of activity, and the degree of reaction produced by a given amount of radium upon normal brain tissue in a known period of time, this work was undertaken. Because dogs are the most available animals, they were used. All the operations were performed under complete ether anæsthesia and every effort was exerted to minimize shock. We placed the radium over the motor cortex so that we might be able to observe any functional disturbances as well as the structural lesions. In these experiments 50 milligrams of radium were placed directly upon the brain cortex, and were permitted to remain there for 4, 6, 12, and 18 hours.

After preparing the field of operation, a semi-circular incision was made, beginning slightly above and behind the eye, extending 1 centimeter beyond the mid-line and ending anterior to the ear. The skin flap was reflected and a second incision made through the temporal muscle five-tenths centimeters from and following its line of attachment to the skull. The muscle and periosteum were reflected downward and a section of bone 2 centimeters in diameter was removed, slightly above and 1 centimeter in front of the ear. The dura was incised and the radium capsule introduced beneath it. The capsule measured 2.5 centimeters in length and it was found that it could be inserted most easily in a downward and forward direction. The bone fragment was not replaced, the anæsthetic discontinued and the wound

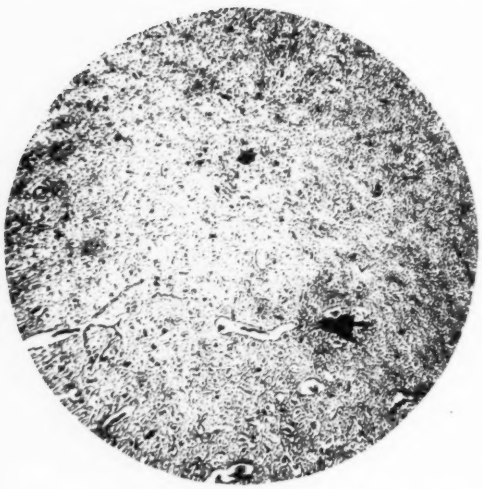

Fig. 1. Dog No. 3. Six hour exposure to 50 milligrams of radium. This area shows degeneration and hyperæmia, but no hæmorrhage (low power).

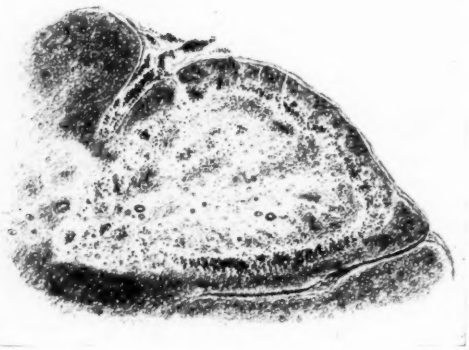

Fig. 2. Dog No. 4. Drawing showing a central necrotic area with thickened blood-vessels. Surrounding this is a circle of hæmorrhage, and beyond this is an area of congestion (low power).

closed. In the interval between the introduction of the tube and its removal, the animals showed no symptoms whatsoever. They appeared absolutely comfortable and did not vomit as do patients sometimes after a pelvic application and even after applications to the head. After removing the radium the bone fragment was not replaced; the dura and musculocutaneous structures were closed with silk sutures.

PROTOCOLS

I. Dog No. 2: 4 hour exposure to 25 milligrams of radium. The dog displayed no signs of discomfort while the radium was *in situ* and made an uneventful recovery; up to the present time, 16 weeks after the radium application there are no signs or symptoms of any sort.

II. Dog No. 3: a 6 hour exposure to 50 milligrams of radium. The dog made an uneventful recovery, and showed no symptoms for a period of 3 weeks, at the end of which he was chloroformed.

Autopsy. The incision in the dura had not healed the edges of the dural incision were necrotic. The tissues of the scalp appeared normal. On the motor cortex was a linear mark 0.4 centimeters wide, and 2.5 centimeters in length. It marked the point of contact of the tube, and grossly resembled an area of hyperæmia. No other lesions were found.

Microscopically that part of the cortex in apposition to the tube showed necrosis of the area to a depth of 2 millimeters. The nuclei showed signs of degeneration, but they had not broken down. The entire area takes the basic stain, there is some hyperæmia, but the blood-vessel walls are not destroyed and there is no hæmorrhage.

III. Dog No. 4: 12 hour exposure to 50 milligrams of radium. The dog made an uneventful recovery, and showed no symptoms during the following 3 weeks, at the end of which time he was chloroformed.

Autopsy. Edges of the dural incision were curled under and discolored. The motor cortex showed an area of hyperæmia 0.9 centimeters wide, and 3 centimeters in length, down the middle of which was a strip 0.4 centimeters wide, black, and necrotic, which marked the area of direct contact of the tube. There were no other findings.

Microscopically the area of degeneration appeared 0.5 centimeters deep. There remained a few cells with marked degeneration but the great majority were entirely destroyed, and the products of their destruction were scattered throughout the necrotic area. In this zone the blood-vessel walls were thickened three to four times their normal thickness, hyalinized, congested, but the walls were intact. Marking the periphery of the necrotic zone was a circle of hæmorrhage, and here the blood-vessel walls, while not thickened, had ruptured. Beyond this hæmorrhagic area the cells appeared to be normal but the blood-vessels were congested. The area was well circumscribed, but there was no evidence of attempted repair.

IV. Dog No. 5: 18 hour exposure to 50 milligrams of radium. He made an uneventful recovery, and during the succeeding 3 weeks showed no symptoms. At end of 3 weeks was chloroformed.

Autopsy. The dura was discolored black over the area of exposure and its edges were curled. The cortex showed a black area of necrosis 0.9 centimeters long, surrounded by a thin zone of apparent hyperæmia. There were no other findings.

Fig. 3. Dog No. 4. Photomicrograph showing sharp line of demarcation between exposed and healthy tissue, 12 hour exposure to 50 milligrams of radium (low power).

Microscopically a necrotic area was found 0.5 centimeters deep. Extending along the surface for a distance of 0.5 centimeter from the point of contact of the tube is a strip of degeneration 1 millimeter deep. All of the cells in this necrotic area are completely destroyed, and their fragments are scattered throughout the zone, but are in greater abundance at its periphery. Surrounding this area of degeneration is a circle of hæmorrhage but in this hæmorrhagic zone the degenerative area is not so sharply circumscribed, but fades more gradually into the normal area. In the necrotic area the blood-vessel walls are decidedly thickened, in the hæmorrhagic area their walls are ruptured, and beyond this there are evidences of hyperæmia. In this section also there is no indication of repair.

V. Dog No. 6: an 18 hour exposure to 50 milligrams of radium. He made an uneventful recovery, and at the present time, after the lapse of 7 weeks, shows no symptoms.

VI. Dog No. 7: a 12 hour exposure to 50 milligrams of radium. He made an uneventful recovery from the immediate effects of the operation but on the second day showed some motor disturbances; at times convulsive and inco-ordinated movements of the limbs, at other times movements athetoid in character with intervals of quiet. On the third day he was chloroformed. Autopsy revealed an encephalitis.

DISCUSSION

The application of radium to the brain of the dog under certain limitations as to time and strength has a destructive action, but

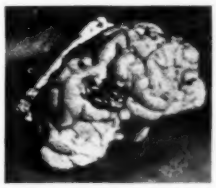

Fig. 4. Dog No. 5. Photograph showing gross area of destruction after an 18 hour exposure to 50 milligrams of radium (low power).

produces no clinical symptoms. The radium, in these experiments, was enclosed in a platinum tube of approximately 0.4 millimeter thickness, which removed the α- and practically all the β-rays, but permitted the passage of the γ-rays.

The difference in the effects produced at different distances from the tube is of extreme interest. Thus, within a radius of 4 millimeters of the tube a 12 hour exposure produces complete destruction of the brain cells and the interstitial tissues with the products of degeneration scattered throughout, but more thickly at the periphery. The blood-vessels within this area, on the other hand, show marked thickening and hyalinization of their walls without rupture. Surrounding this there is a zone 1 millimeter wide in which many of the cells are not completely destroyed but do show evidence of degeneration. In this zone the blood-vessel walls are not thickened but degenerated. As a result of this degeneration they rupture, and one sees an encircling zone of hæmorrhagic infiltration, 1 millimeter in width. This zone is very well outlined and ends abruptly in what appears to be normal tissue, in which the only evidence of the reaction to radium is the slight hyperæmia without changes in the blood-vessel walls. In none of the sections was there any cellular infiltration except from the hæmorrhage, and no evidence of beginning repair.

The time required to destroy malignant tumor cells will depend upon the milligram hour dosage administered on the one hand and on the other the distance of the outermost cells from the radium and the susceptibility of the tumor cells to its action. It has been proven that 600 milligram hours with γ-rays

alone will kill cancer cells to a distance of 1 centimeter. Twice this distance or 2 centimeters requires four times that dose. Sarcomata usually do not require so much dosage. The exact amount required in the case of brain tumors will depend largely on experience, always bearing in mind the law of inverse squares when considering dosage and the size of the tumor. If a dosage is employed presumably just sufficient to destroy a brain tumor of any given size and one which responds to radium *readily*, we may assume from the above experiments that the exposure of the normal brain tissue just beyond the growth is not likely to be of any serious consequence.

CONCLUSIONS

In conclusion we find that:

1. The γ-rays after passing through 0.4 millimeter of platinum penetrate brain tissue and have a destructive action within a radius of 5 millimeters, with a dosage of 900 milligram hours.

2. The effect upon the blood-vessels varies according to the distance from the radium and the number of hours applied.

3. The above experiments give assurance that, in the case of those brain tumors which respond *readily* to radium, little or no damage will be inflicted upon the brain tissue surrounding the tumor, if the radium is implanted in the growth. The dosage employed on the growth can be regulated so as to be destructive only to the periphery.

It is our purpose to examine the brain of dog No. 6 after a period of 4 months in order to determine what reparative processes will take place in that time. It seems advisable also to study the effect of greater milligram hour dosage upon brain tissue. We have begun along similar lines a series of experiments to determine the effect of varying doses of radium upon the spinal cord.

We are indebted to Dr. Frazier, Dr. Pancoast, and Dr. Sweet for the valuable suggestions and the assistance which they have given us.

RECKLINGHAUSEN'S DISEASE WITH SURGICAL COMPLICATIONS

Report of Two Cases

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UNDER the title of von Recklinghausen's disease is included a variety of conditions, fibroma molluscum, neurofibroma, plexiform neuroma. That all these conditions are dependent upon a constitutional vice, probably some abnormality in the endocrine glands, is not unreasonable to assume. A rather extensive survey of the literature leads one to the conclusion that the skin picture formerly known as fibroma molluscum and, since von Recklinghausen's thesis in 1882, as neurofibroma of the skin, is associated with, and often seriously complicated by, other conditions. For this reason von Recklinghausen's disease is no longer to be regarded as a local disease of the skin; but simply as one manifestation of a general or constitutional vice.

These patients are not infrequently of a low grade mentality; there is usually about them something which for want of a better term we might call freakish. The facial features are often exaggerated in size, or lacking in symmetrical proportion. Co-existent with the tumors of the skin, which are quite characteristic, a pigmentation is present sometimes sufficiently marked to suggest Addison's disease. Psychoses of a more or less marked character are present in a considerable number of cases. Tumors of the peripheral nerves, and less frequently of the central nervous system, are found. Skeletal changes and muscular dystrophies occur not infrequently. Tuberculosis is a not infrequent complication. A distinct tendency for cases to belong to the family type has been noticed (1).

Up to the present time nothing has been accurately determined as to etiology, but it is not unreasonable to assume that some one, or more, of the endocrine glands plays a part. In cases of neurofibromata of the peripheral nerves, sarcomatous changes may occur, usually of the myxosarcomatous type, and not disposed to form metastases (2). Neurovascular changes may occur, and one of the cases which I report may have presented such a condition.

It is not the purpose of this paper to enter into a detailed description of von Recklinghausen's disease nor to advance theories as to its causes. What particularly concerns us are such accompaniments of the disease as demand surgical interference. Of these the most conspicuous are neuromata, or more properly speaking, fibroneuromata arising either from the nerve sheath or neurilemma, or from the nerve itself. Unfortunately for the patient, these fibroneuromata are often multiple and invade either a single nerve in large numbers, or are disseminated over various peripheral nerves.

The type known as plexiform neuroma is much less common and may be found in the central nervous system, notably the brain where it may take on the appearance of a glioma. The tendency of some of these neuromata to undergrow sarcomatous change has already been noted. In the event of a single large neurofibroma affecting a single nerve trunk, symptoms of pain and interference of function may warrant surgical intervention. Such a condition is presented in one of my cases.

Von Recklinghausen's disease is not of extreme rarity, and quite a number have come under my notice. In only two have the complications been of a surgical nature, and I take the liberty of relating their history.

CASE 1. Jennie J., age 58, female, white; admitted Cincinnati General Hospital, May 27, 1919; discharged August 4, 1919. The patient is a poorly nourished, poorly developed woman. The facial expression is indicative of low grade mentality; ptosis of both eyelids; pterygium in both eyes; typical picture of von Recklinghausen's disease; multiple neurofibromata over face and body.

Present complaint. Generalized aching, poor eyesight lumps on body.

Fig. 1. Case 1.

Present illness. The patient cannot give accurate history, especially as to time and place. She says her eyesight has been poor ever since she was 11 years old, when a doctor operated upon her; cannot state definitely when the growth over the cornea began. The mentality is evidently very low. The lumps on her body began some years ago as "just simply lumps and kept coming," until now they are spread over the entire body. Some lumps have grown larger than others, but none has caused her any trouble except a very large swelling in the under side of the left arm. This causes pain to pass down along the ulnar side of the arm into the fingers innervated by the ulnar nerve. The pain is more marked when the patient does heavy work, such as washing, etc. The patient now complains of indefinite aching sensations throughout the back, limbs, and anterior part of the chest. No definite type of pain can be elicited but simply a dull aching pain.

The patient has headaches in the occipital region. The headaches are severe, accompanied by nausea and vomting, last 2 or 3 days, and occur "every once in a while." The patient has difficulty in walking because of the eye conditions. She occasionally suffers from œdema of the limbs, and slight shortness of breath. She does not urinate at night and has no burning. She has a slight hacking caugh and expectorates a thick tenacious sputum in moderate amounts, occasionally expectorating a bloody sputum. She has no night sweats. The appetite is poor. The patient has difficulty in swallowing and occasionally suffers from gastrict distress. The bowels are irregular; she uses salts occasionally. She has no jaundice and no melæna.

Fig. 2. Case 2. Fibroma of ulnar nerve, one-third natural size.

Fig. 3. Case 2. Gluteal tumor.

The patient claims she had "scrofula," measles, mumps, and small pox as a child; tonsillitis occasionally. She gives no traumatic history although there is a question as to the left ankle having been broken.

The father and mother both are dead, the father having succumbed to Bright's disease and the mother to an unknown cause. One brother is living and well; one brother died two years ago from Bright's disease; two sisters are living and well; one sister died from cardiorenal disease. The family history reveals no history of tuberculosis, cancer, or mental disease.

The patient is single, gives no history of miscarriage, and denies venereal disease. She takes whiskey as "toddy" occasionally; drinks no beer, but does take coffee and tea—about 3 cups a day. She has done housework all her life.

Physical examination of surgical condition. Scattered over the trunk and limbs of the patient are numerous, irregular soft, fat-like masses, varying in size from that of a small pea to that of a walnut. These masses are more pronounced over the nipple region of each breast and along the anterior part of the chest and abdomen. In the left epigastric region, just beneath the costal border and about 1.5 inches from the mid-line, is a soft, round, globular fat-like mass about the size of a small egg, not painful or fluctuant. Along the posterior aspect of the left triceps muscle is an elliptical, sausage-like, rounded, smooth mass about 12 centimeters long and apparently 5 centimeters in thickness. The mass is freely movable beneath the skin, and does not change position upon contraction or relaxation of the muscles of the arm. Upon palpation, the patient states she has a tingling sensation down the ulnar side of the forearm and into the ring and small fingers of the left hand. There is a marked atrophy of both thenar and hypothenar eminences with a marked thinning of the interosseous spaces. There is a persistent flexion of the small and ring fingers (claw-hand). The left arm and forearm are atrophied to a considerable extent.

Operation, June 22, 1919. Local anæsthesia (apothesine) was used. An incision about 10 centimeters in length was made along the inner border of the biceps muscle. The skin and fascia were severed. The tumor mass was found to be lying in the path of the great vessel of the arm, pressing on the median nerve and brachial vessels. The basilic vein passed over the mass. We opened the fascial covering of the mass which was found to be a nodular enlargement of the ulnar nerve about 10 centimeters long. The nerve was exposed above and below the tumor mass, and the mass removed. The bleeding points were ligated and the fascia and skin closed with catgut sutures. The patient left the operating room in fair condition. She complains of severe pain in the left arm about the incision. She sleeps well, has vomited considerably since operation, but is not uncomfortable.

June 24, 1919. The patient apparently is very weak. She complains of lack of appetite. Eichberg's tonic was given. The patient has much pain in the arm which keeps her from sleeping. For the relief of this morphine was given.

June 27, 1919. The patient seems somewhat better and complains less of pain. She has some slight movement in the ulnar distribution of the hand; flexion is very poor.

June 29, 1919. The patient's condition is very good. She is up and about, and has little pain in the arm. She eats fairly well.

Pathological report by P. G. Woolley. The tumor mass was preserved in formalin. It was ovoid, firm, elastic, measuring 13.5 by 7 by 6.5 centimeters. It had the appearance of being an encapsulated mass, the capsule being composed of fibrous tissue, the strands of which were arranged for the most part transversely to the long axis. At one pole was a teat-like projection that was evidently a section of a large nerve incompletely lobulated. An attempt to dissect the mass, commencing with the nerve trunk, was made and was unsuccessful, for it seemed that the sheath of the nerve was continuous with the capsule of the tumor, and that the nerve trunk itself disappeared. The appearance suggested, therefore, that the tumor itself had arisen within the trunk of the nerve and that the nervous tissue

had been destroyed by the growth, or that the fibers had been so separated that there was more or the normal coherence. On section of the mass—a complete longitudinal section—it appeared that there was a capsule quite distinct from the mass of the tumor, and that the latter was composed of fibrous tissue, which according to its position was clear white and hyaline (in the center); œdematous and translucent (scattered). At one point near the pole to which the nerve fragment was attached, in the capsule, was an area of calcification. There was no microscopic evidence of nerve tissue. Tissue for histologic study was removed from four different points to represent all depths of the tumor mass.

The histologic sections all show practically the same changes in each. Such variations as are present relate to degenerative changes and to cellular infiltrations. The whole tissue is composed of fibrous tissue with no discoverable neural tissue. In the solid, firmer portions of the tumor this fibrous tissue is richly cellular and is infiltrated with numerous small round cells. In the softer portions the fibrous tissue which is formed of larger and smaller bundles is poor in nuclei and the bundles are swollen and œdematous. There are a few pale giant nuclei due to the œdema. In the yellowish areas the fibrous tissue is undergoing degeneration and in these areas lime salts are deposited in smaller and larger amounts. There are numerous microscopic concretions. The capsule is composed of pure fibrous tissue.

Case 2. N. D., age 50, female; admitted to Cincinnati General Hospital, March 9, 1917. The patient is a fairly nourished, fairly developed white woman. The facial expression and manner are suggestive of psychical peculiarities. The family history is irrelevant. The patient has had the usual diseases of childhood. Her health is unusually good. For years she has had scattered over her body numerous small tumors, some sessile, others pedunculated. She presents a typical picture of fibroma molluscum or fibroneuroma.

For twenty years the patient has noticed a swelling in the right upper gluteal region, what she thought was fat. On February 8, at 11 p. m., the patient noticed that the swelling had become larger and was becoming painful. Since then it has continued to increase in size and is very painful. It now presents a large and fluctuating tumor mass. Ecchymosis is present over the tumor mass. The blood count shows red cells 4,240,000; white, 14,200. The pain in the tumor is increasing and involves the whole right thigh. The tumor was aspirated and a dark red fluid obtained. Ice caps were applied. The patient was under observation for 5 days. The temperature ran from about normal in the morning to from 100.6° to 101° in the evening.

March 16, the patient was operated upon. A large mass of apparently fatty or myoid tissue was removed. Hæmorrhage was very free, necessitating the ligation of branches of the gluteal artery. The wound was closed with rubber tissue drain, and the patient was returned to the ward in good condition. The wound continued to drain blood and serum in slight amounts and the discharge had an offensive odor. The patient's temperature dropped to normal on the third day and remained so for several weeks, when on April 10, her temperature suddenly went to 104°. She suffered an attack of erysipelas, and was transferred to the dermatological service, from which she was discharged well, May 7, 1917.

Pathological report on tumor, by Paul G. Woolley. The tumor is a mass of orange colored fatty tissue filled with hæmorrhages, which at one place is collected into a clotted mass that resembles that seen in aneurisms. There is no evidence of growth of the tumor tissue nor of the aneurismal wall. Sections of the tumor show no evidence of new-growth, but merely fibroid adipose tissue in close diffuse association with large amounts of granulation tissue. There is no vascular or aneurismal wall tissue.

This rather unsatisfactory and indefinite protocol from a diagnostic standpoint has led me to believe that I was right in my surmise that this growth was the product of degenerative changes in a large neurofibromatous mass, with accompanying neurovascular changes. Before operating I had in mind one of those myxosarcomatous tumors which sometimes supervene in these neurofibromata. I am not yet convinced in my own mind that such was not the case.

One feature in this case which may have a bearing on the statement that relaxed musculature is an accompaniment of disease is that the patient had a left inguinal hernia which I subsequently operated upon and found a diverticulum of the urinary bladder in the sac, which had no covering of muscle fibers but consisted simply of a peritoneal coat. This led to the belief at first that I was dealing with a hydrocele of the canal of Nuck.

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THE INTERPRETATION OF MUSCLE FUNCTION IN ITS RELATION TO INJURIES OF THE PERIPHERAL NERVES[1]

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THE material for this discussion was collected in the neurosurgical service of General Hospitals, No. 11, Cape May, N. J., and No. 41, Staten Island, N. Y. A few observations made on private patients have been included to emphasize certain phases of the subject not supplied by the writer's data gathered in these reconstruction hospitals. All of the army patients had received wounds at least several months prior to coming under observation, and the majority of them were studied for several months under conditions highly favorable to the investigation of the motor disability of peripheral nerve injuries. The cycle of disturbed function, ranging from great enfeeblement or total paralysis to complete return of muscle action, could often be noted during this period of observation.

The degree of disability following an injury of a peripheral nerve is estimated primarily in terms of voluntary movement, the sensory and trophic loss usually being of much less consequence than the motor impairment.

Recovery of voluntary movement is the most valuable evidence of regeneration of the paralyzed nerve from the standpoint of diagnosis and treatment. As a corollary incomplete examinations of muscle function have assigned to useless methods of nerve repair a value which is entirely unwarranted and can be disproved by careful study of the involved muscle groups. Accurate interpretation of voluntary movement requires careful and repeated examination of the affected muscles. A knowledge of the normal muscle action is often bewildered by the modification of an engrafted and persistent functional element. Associated lesions of the bones, joints, blood-vessels, muscle bellies, and tendons frequently becloud the clinical picture. Much study is required in cases of combined injuries to dissociate the lesions accurately and assign to each its share of the responsibility for limitation or loss of voluntary movement. Analysis, on an anatomic basis of muscle function as it is modified or abolished primarily by the nerve lesion, is the purpose of the present paper.

In the interpretation of muscle function in the distribution of an injured peripheral nerve, the chief difficulty arises from the unexpected appearance of voluntary motion in segments of the limb supplied by the nerve in

Fig. 1. Paralysis of the left deltoid. Elevation of the arm by the supraspinatus assisted by the fixation muscles of the shoulder.

Fig. 2. Atrophy of the brachialis anticus.

[1] Read before the Southern Surgical Association, at New Orleans, December 16, 1919.

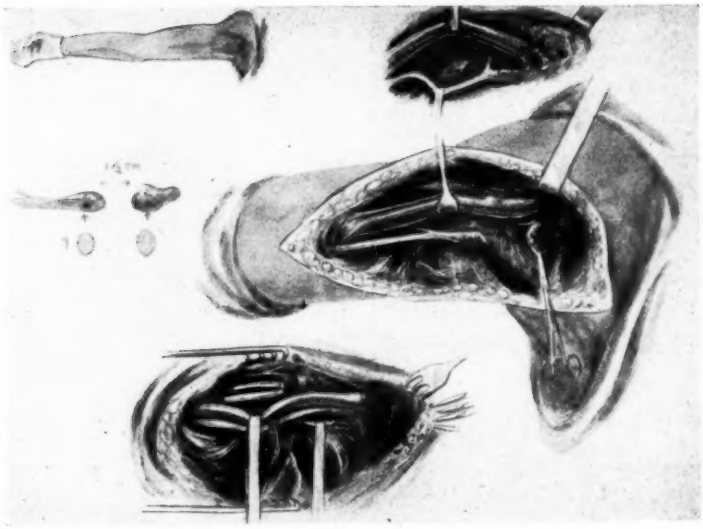

Fig. 3. Division of right musculospiral nerve above branches to triceps. Complete loss of extension of forearm.

question. Frequently the movement normally executed by the paralyzed muscle of the first order is accurately replaced by the action of subsidiary muscles supplied by a healthy nerve. The contributory action of these subsidiary muscles may appear only after paralysis of the muscles primarily responsible for the movement, and under such conditions the motor function of the normal neuromuscular mechanism may be closely imitated. Substitutionary muscle function or the "supplementary motility" of Letievant has been carefully studied in the peripheral nerve lesions of the late war. Practically all of the common substitutions were noted and most of them repeatedly observed in patients of this series. Months of intelligent effort on the part of the patient had developed the replacement of function by the substitutionary muscles to a confusing degree in many cases.

In the examination of voluntary movement, Tinel's (1) suggestion that the limb be placed in a position to abolish the opposing force of gravity, is very pertinent; otherwise feeble movements of a recovering muscle may escape observation.

Fig. 2a. Musculospiral paralysis of the right arm with paralysis of brachioradialis. Cut to left shows normal action of the brachioradialis in forcible flexion of forearm

Fig. 4. Flexion of the forearm by the pronator radii teres in patient with paralysis of the musculospiral and musculocutaneous.

Fig. 5. Flexion of wrist against orce of gravity by the extensor ossis metacarpi pollicis in complete paralysis of all muscles supplied by the median and ulnar nerves.

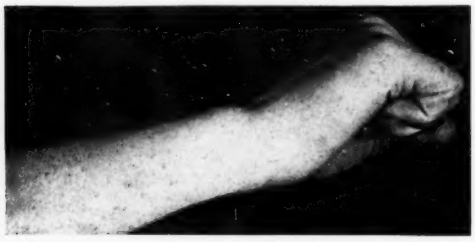

Fig. 6. Extension of the wrist by forcible flexion of the fingers in musculospiral paralysis.

Fig. 6a. Wrist drop of musculospira paralysis with slight hypotonia.

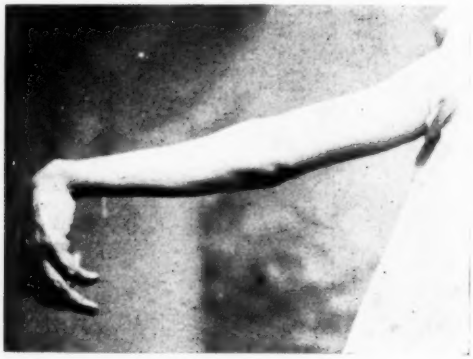

Fig. 7. Musculospiral paralysis of fourteen years' duration. Patient has never worn a splint. Extreme hypotonia of extensor muscles of forearm. Forcible flexion of fingers produces no elevation of wrist.

Fig. 8. Extension of wrist by ong radial extensor with deviation to the radial side. Paralysis of all other extensors of the wrist and fingers.

Fig. 9. Abduction of thumb in ulnar paralysis

The larger number of substitutionary movements in patients with peripheral nerve injuries is found in the muscles of the upper extremity and particularly in the intrinsic muscles of the hand. Here the convergence of all the larger nerves of the arm with the action of each, sometimes reinforcing and again overlapping that of the others, may produce deceptive motor phenomena when one or more of the large nerves of the arm is injured.

The subject may be better presented if the components of function of the various seg-

Fig. 10. Abduction of thumb in right musculospiral paralysis.

Fig. 11. Characteristic griffe in low esion of ulnar.

Fig. 12. Ulnar paralysis. Note griffe, atrophy of adductor of thumb and digital interossei.

ments of the upper extremity be studied consecutively from the shoulder to the hand. In my observation of paralysis about the shoulder girdle and upper arm, substitutionary muscle function was not often noted. There was one patient, however, with complete paralysis of the deltoid, who was able to raise the arm above the level of the shoulder (Fig. 1). This is an unusual substitu-

Fig. 13. Same patient as in Figure 12, showing complete extension of distal phalanges when hyperextension of proximal phalanges is overcome.

Fig. 14. Complete interruption of median and ulnar in upper arm. Flexion of fingers by extension of the wrist.

Fig. 15. Complete paralysis of all median muscles, due to anatomical interruption of nerve in upper arm. By extending the wrist the patient is able to make considerable flexion of the index finger.

tionary action brought about principally by the supraspinatus in conjunction with the

Fig. 16. Musculospiral paralysis. The two distal phalanges can be raised from the table by the action of the interossei and lumbricales.

trapezius and other fixation muscles of the shoulder. This case is of interest because of the common belief that substitution for the deltoid by the supraspinatus is ineffective and feeble.

MOVEMENT OF THE UPPER EXTREMITIES

Flexion of the forearm. The mechanism for flexion of the segments of the upper extremity is well protected and exceedingly adequate. Flexion of the elbow is produced by the action of the musculocutaneous, median, and musculospiral nerves. Flexion of the wrist may be effected by any one of the same nerves, while the movements of extension of these joints depend almost solely upon the musculospiral.

Paralysis of the musculocutaneous nerve abolishes the action of the biceps and usually the brachialis anticus, the muscles of the first order in the flexion of the forearm (Fig. 2). Satisfactory flexion, however, can be produced by the solitary action of the brachioradialis supplied by the musculospiral, and flexion performed by this muscle is accurate and efficient (Fig. 2a). The musculospiral supply of the brachialis anticus is a factor in flexion of the elbow, in some

Fig. 17. Appearance of hand in high median and ulnar paralysis. Flattening of the hand due to atrophy and unopposed pull of the extensors.

Fig. 18. Spreading and complete extension of the fingers by long extensor simulating action of the interossei.

cases. The pronator radii teres is also a flexor of the forearm, and one patient with paralysis of the musculocutaneous and musculospiral was able by practice to accomplish considerable flexion by developing the substitutionary pronator action (Fig. 4).

Extension of the forearm. Extension of the forearm is accomplished entirely by the musculospiral nerve. Complete loss of extension of the forearm is infrequent in musculospiral paralysis, because the long head of the triceps receives its motor supply immediately after the nerve leaves the tendon of the teres major. Higher lesions of the musculospiral are very likely to involve either the brachial plexus or the other large nerve trunks of the axilla. One such case with loss of forearm extension due to musculospiral paralysis was operated upon. The lesion consisted of an anatomical interruption of the nerve just below the circumflex (Fig. 3).

Pronation. Complete pronation of the forearm is effected by the pronator radii teres and

Fig. 19. A favorable position for the detection of feeble voluntary movements of the leg and foot. The board should be well polished to permit freedom of movement, while the force of gravity is abolished.

quadratus supplied by the median. In paralysis of the median above the elbow, no cases of substitution of normal pronator function were seen. The brachioradialis is capable of bringing the forearm to the neutral position; that is, midway between pronation and supination. Rotation of the radius internally beyond the neutral position was invariably the result of the action of the muscles normally responsible for the movement, and was not observed as a substitutionary movement.

Supination. Supination of the forearm with the elbow flexed is the result of the action of the biceps and supinator brevis. The brachioradialis is not a supinator of the forearm. It enters into this supination and can rotate the radius to the line of the neutral position, beyond which further supination is accomplished by the biceps and supinator brevis. With the forearm extended and external rotation of the upper arm by the muscles of the shoulder forcibly prevented, the action of the biceps as a supinator is generally abolished, although this point is contested by Woods (2), who maintains that even with this precaution the biceps may cause supination.

Movements of the wrist. Flexion of the wrist depends normally upon the action of three muscles, two of which are supplied by the median and one by the ulnar. Interference with the palmaris longus and carpi radialis (median supply) does not abolish flexion with deviation to the ulnar side by the carpi ulnaris (ulnar supply). Anatomical interruption of both the median and ulnar nerves would suspend flexion of the wrist, but for the considerable substitutionary flexion brought about by the extensor ossis metacarpi pollicis supplied by the musculospiral (Fig. 5). This substitution can be easily detected in median and ulnar lesions by passively moving the wrist to a position of hyperextension. Action of the extensor ossis with the hand hyperextended does not produce flexion of the wrist, but on the contrary assists in maintaining the extension. The extensors of the wrist are innervated by the musculospiral nerve acting principally through the extensor ulnaris and the short and long radial extensors. The communis digitorum and extensors of the thumb also participate in extension of the wrist. In musculospiral lesions above the elbow, it has been frequently observed that the patient could elevate the hand by making forcible flexion of the fingers. This observation has been made by Benisty (3) and others, and was repeatedly verified in our experience (Fig. 6). The requirement for the dorsal elevation of the hand under such circumstances is a slight shortening of the extensor tendons (Fig. 6a). The movement cannot be accomplished, as pointed out by Pollock (4), if a considerable degree of hypotonia exists (Fig. 7). The army splint in common use for complete musculospiral paralysis is no doubt largely responsible for the patient's ability to execute this movement which is easily explained upon a simple mechanical principle as follows: the distance between the origin and insertion of the shortened extensors must be diminished to enable the patient to make forcible contraction of the fingers with muscles supplied by the healthy median and ulnar nerves. The distance necessary to enable the patient to make a fist is gained by the compensatory elevation of the hand. This explanation appears more logical than that offered by Hunt (5) based on the hypothetical projection through the peripheral nerves of differentiated tracts from the cortex and striate body.

Wrist adduction and abduction are the result of combined action of the extensors and flexors of the joint, although a certain amount of adduction is possible in paralysis of the extensors through the action of the flexor ulnaris. This adduction, however, is incomplete and faulty, and is accompanied by ulnar deviation. The extensor ulnaris if acting alone is capable of effecting slight adduction without the assistance of the flexor ulnaris; whereas the radial extensors acting alone produce abduction with extension of the wrist (Fig. 8).

Thumb movements. Flexion and extension of the thumb are not effectively compensated when the primary muscles for these movements are paralyzed. A slight dorsal pull on the distal phalanx may occur as a substitution for the action of the paralyzed extensor longus

pollicis when the opponens and flexor brevis pollicis carry the thumb across the palm. When this is done, a shortened extensor of the paralyzed longus pollicis may act as a guy rope on the distal phalanx and produce extension. This movement is similar in mechanism to that causing elevation of the hand in musculospiral paralysis by making a fist.

Adduction of the thumb or approximation of the thumb to the radial side of the second metacarpal segment, is produced primarily by the adductor pollicis (ulnar supply) and flexor brevis pollicis supplied by the median and ulnar. The opponens and extensor ossis metacarpi pollicis of the musculospiral group also assist in adduction of the thumb. Fixation of the thumb by the extensors is essential to every efficient action of the intrinsic thumb muscles. Movement of the thumb to a position perpendicular to the palm, or abduction, is effected chiefly by the abductor pollicis supplied by the median (Figs. 9 and 10). The extensor ossis metacarpi pollicis and opponens also take part in abduction. This movement is a good test of median function and should not be confused with extension of the thumb. Approximation of the pulp of the thumb to that of the fingers depends upon the integrity of the median nerve acting through the opponens and adductor. The tip of the thumb may be placed in contact with the pulps of the fingers by the flexors of the thumb when the median is paralyzed, but the normally acting opponens supported by the abductor and extensors can oppose the thumb and fingers at the level of the last articulations. Rotation of the thumb is an opponens movement facilitated chiefly by the attachment of the opponens to the metacarpal bone and not to the phalanx of the thumb (6). Rotation involves the action of all the muscles of the thenar eminence, the adductor and the long thumb extensors.

Movements of the fingers. Complete flexion of the fingers is produced by the median and ulnar supply acting on the flexors sublimis and profundus digitorum assisted by the interossei and lumbricales. Our observations support the view that all the interossei including the adductor of the thumb are supplied by the ulnar. The action of these muscles, in flexing the first phalanges and extending the second and third, is reinforced by the lumbricales, the inner two of which are supplied by the ulnar and the outer by the median. Forcible flexion of the phalanges by the profundus acting alone, if continued, produces flexion of the second and finally the first phalanges. Atrophy of the interossei results from ulnar paralysis and is not evident in the case of injury to the median alone. The characteristic ulnar griffe (Fig. 11) is more pronounced in low lesions of the ulnar and the mechanism of its production results from the unopposed hyperextension by the common extensors (Fig. 8) of the first phalanges of the ring and little fingers. The two distal phalanges are partly flexed by the pull of the sublimis and profundus digitorum. The action of these long flexors of the fingers in ulnar lesions is unopposed in the second and third phalanges of the fingers by paralysis of the interossei and inner two lumbricales which normally extend these phalanges. The index and middle fingers are not affected in ulnar griffe because of the median supply acting through the lumbricales, which are feeble antagonists of the common extensor action. By supporting the first phalanges of the ring and little fingers of a patient with ulnar griffe, complete extension of the fingers may take place (Figs. 12 and 13). In combined median and ulnar lesions, the patient is able to produce moderate flexion of the fingers by extension of the wrist (Fig. 14). The flexion movement of the fingers, thus performed, is produced by the increase of distance between the fixed points of origin and insertion of the inelastic long flexors, in the act of extension of the wrist. As the wrist is elevated in extension, the fingers are pulled down to a point within the length of the flexors which have been made to assume a curve by the extension of the wrist. Although the flexor profundus is partially paralyzed in high median lesions, the patient is generally able to flex the three inner fingers forcibly, due to the fact that the profundus slip to the middle finger is supplied by the ulnar nerve. The principal disability of a median injury so far as finger movements are concerned is

inability to flex the first finger, and even this movement of the index may be effected in some cases by extension of the wrist (Fig. 15).

Extension of the fingers. In musculospiral paralysis the patient is unable to extend the first phalanges. By supporting the primary phalanges, however, extension of the two distal segments of the fingers is easily accomplished by the interossei and lumbricales (Fig. 16). Extension of the two terminal phalanges of the fingers is not always abolished by paralysis of the interossei and lumbricales. In many cases of ulnar paralysis, the common extensors are capable of making complete extension of all the segments. Although the musculospiral nerve does not supply any of the intrinsic hand muscles, the function of all of these muscles is seriously impaired by paralysis of that nerve (Fig. 17). By its action through the extensors, the stability of points of leverage of these intrinsic muscles is made effective.

Lateral movements of the fingers. Lateral movements of the fingers are effected chiefly by the interossei, but substitution for both adduction and abduction of the fingers is found frequently in the action of the long flexors and common extensors of the fingers. The common extensors are capable of spreading the fingers in accurate imitation of the action of the interossei, while the contraction of the long flexors causes adduction of the fingers (Fig. 18). Great care is necessary in determining interossei action in the movements of adduction and abduction of the fingers. The fingers should be flexed at the metacarpophalangeal joints to eliminate the action of the long extensors. There is no sign by which ulnar paralysis can be positively determined by examination of the voluntary movements of the fingers. The ability to superimpose the extended little finger upon the palm of the ring finger is a simple and practical test of ulnar function in the majority of cases. In some injuries of the ulnar nerve the amount of disability is so slight that an estimate on an anatomic basis exaggerates the importance of the lesion. The refinements of finger motility are usually impaired by ulnar lesions.

LOWER EXTREMITIES

Interpretation of muscle function of the lower extremity is much simpler than that of the upper chiefly because of the minor importance of the intrinsic foot muscles as compared with those of the hand. Attention has been directed principally to the disturbance of the coarser muscles in the investigation of voluntary movement of the lower extremities (Fig. 19). Substitutions of movement are not frequent. Flexion of the leg and thigh is rarely abolished in sciatic paralysis because of the preservation of function of the semitendinosus. This branch leaves the trunk at a high level and usually escapes injury. No case of sciatic paralysis operated upon by me showed inability to flex the knee because of the nerve lesion.

Extension of the leg was rarely a matter of investigation in the series, because of infrequency of anterior crural paralysis. One such case, now under observation, shows substitution for the quadriceps action by the tensor fascia femoris supplied by the superior gluteal. Walking is characterized by hyperextension of the knee maintained in this position by the tensor fascia femoris, and the usual secondary hydrarthrosis is present. Supplementary movements of the ankle-joint are fairly frequent when the muscles of the first order are paralyzed. Inversion of the foot effected by the tibialis anticus supplied by the external popliteal may be simulated by the tibialis posticus unless the foot is held at right angles. Substitution for the loss of dorsiflexion of the foot was not observed. Plantar flexion normally accomplished by the calf muscles may be produced by the action of the perineus longus.

Movements of the toes are sometimes confusing when the contraction of the antagonists of the paralyzed muscles is followed by a rebound simulating the normal action of the muscles under investigation. If the dorsiflexors of the toes are paralyzed, and the patient attempts to contract the paralyzed muscles, plantar flexion of the toes may be the initial movement followed by a rebound of the toes to the original position. The rebound resembles slight dorsiflexion and may be deceptive.

The movement desired should take place from the position of rest without a preliminary motion of the antagonist. Errors may be avoided by analysis of the components of the movement.

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INFECTIONS OF BONES AND JOINTS[1]

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THE especial reason for bringing forward this subject is not that we have solved—much less that I have solved—the important practical problems presented, but that it is a time of general interest in these problems, a time most opportune for formulating both the problems and the work to be done toward their practical solution. Every active surgeon knows how little under our control these problems have been in the past and is eager to welcome the time when we can deal with them with a reasonable confidence and certainty.

The commonest infective condition is that of bone infection from without, in compound fracture, a problem freshly familiar to many in war wounds.

War experience can not all be transferred to civil practice in this or in other fields but the war work has answered many of the questions that lay open; we are already equipped to save more lives and limbs, and in the future the not unusual cases of chronic wound sinuses should be few. There are cases, of course, of virulent infection and low resistance in which progressive infection, and far-reaching damage and even deaths are unavoidable, but they are rare.

We are not going to follow war routine in civil life: primary débridement, sometimes overdone even in war, has little place in peace, and in civil life we need not assume infections before they occur, but we are not going to do closed suturing on doubtful cases any more if we have learned our lesson,—we are going to operate on infected cases frankly and not hope for days that they may recover, and when we operate we are going to do a surgical job.

We have learned that wider cleaning out and drainage than used to be used is a first essential both for limiting infections and for later disinfection, and that disinfection is possible, if wounds are really opened up: first, an approximate disinfection before the final surgical clean-up, then a real disinfection after the clean-up and thereafter a relatively rapid healing. We not only know this can be done but in our better hospitals we are doing it.

Wide opening-up has two functions: first, helping in the disinfection by providing better drainage, minimizing burrowing, and giving access to the disinfectant; second, by giving a better chance to keep track of the necrosed bone fragments in the wound and thus seize the earliest moment for the final clean-up after the bacterial count goes down.

In almost every infected bone-wound one gets sequestra. These must come out before we can get healing and should come out as soon as the line of demarcation is established. This time averages 6 to 8 weeks, but more exactly we learn by seeing or by feeling with the probe the ragged line itself beneath the edge of the granulations. Also we can tell

[1] Read before the Chicago Surgical Society, February 6, 1920.

with the X-ray, very accurately as a rule. One point often overlooked is that sequestra do not show the osteoporosis of the surrounding bone but stand out in denser shadow[1]; the progress of the demarcation from surrounding bone can be followed clearly if one keeps this in mind.

When one speaks of disinfection of these wounds one means disinfection by the Carrel-Dakin technique, accepted now, I think, by all who have *really* tried it, as *the* method. Certain substitute methods worth considering will be dealt with later in connection with osteomyelitis; they belong, however, to later stages and have no bearing on recently infected fractures and wounds.

One thing in which we cannot follow the war routine I think, is in the ultraradical handling: not only primary débridement, but the ultraviolent secondary laying open of wounds has sometimes seemed a fetish. There is no advantage in doing more than a wide open exposure; the conversion of a wound into a sort of platter with a slant section of most everything in the limb serves no purpose.

Again, wholesale removal of loose bone fragments may often and easily be overdone. There are many ex-service men still waiting with flail-limbs, with a long or short section missing from the bone, and nothing to replace or repair it with, often too scarred-up for clean grafting operations without grave risk of slough and sepsis. I have seen a good many myself, results partly of trauma, infection, and hard luck, but also of zeal not quite well directed. We can at least regulate the zeal if not the other factors.

Generally speaking, remove no bone early when there is infection, but insure wide-open drainage, disinfect, and wait for demarcation. Often I have seen what I thought a wholly dead fragment yield only a scale of sequestrum and then go on to do its part in repair.

Fixation is important in these cases partly for rest, more to give decent position for repair when repair begins in earnest.

There has been a bit of confusion about the use of the Army splints in fixation. In the main they were meant to be used as transportation splints—a purpose for which they are admirable. Even the traction splints for the arm, which I loathe, are admirable for the transportation and even the early treatment of a humerus shattered by a shell wound and all of them are good for the work they were meant for.

But they do *not* solve the problem of fixation during treatment for ultimate repair. There can hardly be a worse way of ensuring non-union in a shattered humerus than keeping it under continuous traction, and this says nothing of the lamentable results on the shoulder muscles and joint.

Even the Thomas splint (now vaunted as a cure-all application just as if it were not older than most of us) excellent as it is, is of service, save for the emergency, only when rightly applied and most skillfully adjusted and attended. The Steinmann nail and the Blake tongs have a limited use only and only in skillful hands, and can do much harm.

In short the problem of external fixation is about where it was before the war so far as civil cases are concerned, and if we were to forget all but the aeroplane arm splint and the "cock-up" wrist splints there would be no serious loss.

We must treat each case to ensure for that case the most accurate adjustment and best contact of fragments we can, just as soon as our problem ceases to be one of sepsis only, and that should be a matter of days not weeks.

The question of direct fixation in the wound is still debated. I used it long before the war, still use it, still avoid it when I can, yet there is no objection to holding fragments against wide separation with a loop of suture or a perforated plate to which the bone ends are lashed, and this method has proved of service in my hands and does not interfere with sterilization. Plates of the Lane type do not belong in an infected wound; they are undesirable enough in a clean one.

The question that remains after all these matters of sepsis, etc., are over is one of union, and here we have much to learn. I have had little luck in healing infected compound fractures with small scars and the secondary suture operations rarely help much in this

[1] This is also true of aseptic bone portions cut off from blood and nerve connections, rarely a source of confusion.

regard in bone infections. The scars of the war wounds are usually enormous, and preclude any early clean grafting. Whether after a year or two such operations may be safer I do not know; many of the soldiers are waiting in this hope. It is a long wait.

The civil case averages better and often enough healed compound fractures may be dealt with for non-union just as the simple fracture, but often enough also we meet cases in which wide defects in bone and extensive, deeply adherent, ill-nourished, scars together present the unpleasant problem.

Unfortunately the heightened productive power of the periosteum one sees in ordinary osteomyelitis is here absent; they repair languidly and incompletely and in only too many cases go on to non-union with finished bone-ends and more or less deformity as well. We are not today in a position to handle all these cases with any real assurance of success. One of the things most to be desired in surgery is some way of determining repair toward real bone repair, instead of fibrous tissue, whether the defect be in clean or infected or disinfected bone. Salvarsan, thyroid extracts, the feeding of lime, etc., serve the occasional case, they by no means solve the working problem.

Today we attack it by waiting, with some successes, or we do bone grafts which do succeed but by no means always. These grafts if they succeed do grow, but more particularly they are the starting point for bone-growths about them. May it be that they act in part to *supply* the lime salts they lose (as successive X-rays show in most cases) to their neighbor bone cells and to the surrounding indifferent granulation tissue?

If we could directly stimulate bone growth in this granulating callus mass so as to bring about bone-formation instead of fibrous tissue growth between bone ends, all would be well. Histologically the two processes start alike—the difference is that in the less fortunate cases the transformation of granulation tissue into calcified tissue, later to become true bone, is lacking.

Is it within the range of possibility to control this? Perhaps. We know that the salts of urine do at times produce calcification within tissue, as to wit, the deposits in ureteral plastics.

Our laboratory workers have told us that magnesium has a stimulant effect on bone production. Some 4 years ago I tried this out clinically on one compound and one closed fracture, both with long delayed union. At all events both did well. At present there is one case under treatment, an open fracture. There seems to be something in this treatment. Practically its value is limited and in closed fractures the hydrogen resulting from the conversion of the magnesium in the tissues is a nuisance.

There is another lead. Following the unsupported supposition that live grafts and boiled beef bone may perhaps be of value primarily as a source of lime, I tried, about the same time as the magnesium, another scheme of interference, namely the local injection of insoluble lime salts. There were only a couple of cases but results were good enough so that now I am back at work, the scheme is being tried out again.

Obviously all my laboratory and experimentally minded friends are going to look upon this as ungrounded in theory, but that interests me but little; the question is, does it work? This can be answered only by clinical experiment and there have proved to be certain technical inconveniences in doing precise work but I hope to report before long for or against. If this does not prove the practical answer perhaps something can be done along the line of urine salts or their chemical equivalent.

I am minded to go further with all three of these methods and hope to see the day when we can cure clean non-unions by grafting, unclean or heavily scarred and therefore prospectively septic cases by depositing nutrient and stimulant stuffs in the gap, whether the gap be open or closed.

The second class of infections under consideration are those of osteomyelitis of the familiar hæmatogenous type, always with us, always a bit unsatisfactory. I should hardly venture on consideration of this much bewritten type of disease, save that the voluminous literature on the subject seems to me a confusion, a sort of Babel of

mixed pathology and surgery out of which there has emerged only one clear voice in late years—that of the prophets who preach the "ideal" operation. I suspect they are false prophets.

The "ideal" operation, so-called, is that of subperiosteal resection after the completion of necrosis and of sequestrum separation. This, an operation post mortem of valuable tissue, seems scarcely ideal.

It is only better than the patch work after many months of neglect in that it postulates only weeks of neglect.

If there is an "ideal" operation for osteomyelitis—if there is an ideal—then it must concern itself with the *abortive* treatment, with a treatment that renders the much advertised subperiosteal resection a superfluous *tour de force*.

We have very much misconceived the every day clinical pathology of osteomyelitis, and this is so largely because we have followed the book.

It is true that one meets at times the explosive type set forth in all good textbooks. The case of the boy of thirteen who disregards the advice of his wise if elderly aunt and goes swimming in the old swimming hole, comes back to supper, late, listless, sad, and feverish, and is presently diagnosed as typhoid fever or brain fever, or any fever next evening, and by the third day someone opens a bone abscess, and after that does various, complicated, and eventually bone-grafting things to the boy.

As I have seen things happen, this is rare. Most cases are more deliberate. There is at least a three-day interval between pain and fever and necrosis, and more often it is a week. One has ample time to get scared and back again before actual *massive* necrosis begins.

The pathology of osteomyelitis is familiar, but, may I venture on a rough review of the condition as I have met it in recent years; not as a pathological review, but as notes on the clinical pathology by a clinician?

First, we call osteomyelitis of this type hæmatogenous and it is as a rule, but there are not a few cases (I have seen two since summer) in which a local sepsis in the limb has been followed by a true osteomyelitis of a bone higher up the limb without other foci and without direct invasion, possibly by lymphatic transfer, like that which gave us infected joints higher up the limb in the war wounds.

Also direct invasion of bone from the soft parts does occur, most often in infections of the hand.

Second, the book picture we were all brought up on, the above-noted small boy who gets chilled swimming, comes home and presently shows a desperate typhoid picture, semiconscious, etc., is perfectly true but misleading. We have all seen it, but far more often does one meet the case that goes on for a week before the patient shows obvious severe symptoms. These I find more common and often misunderstood, or overlooked because they do not fit the copy book account.

Third, by no means all cases show extensive sequestra even with the history of a severe onset. An extensive area may be involved with very little bone destruction, and this may happen even in the absence of anything more than the crudest surgery.

Fourth, the low grade local focus called a Brodie's abscess may take care of itself, or rather the focus may and often does disappear rather than go on to a proper abscess.

Fifth, lacunæ in the X-ray may not mean foci of persisting infection but merely irregular repair. Here again the X-rays will illustrate.

Sixth, there may be extensive penetration from the original focus up along the marrow, but unless there be *pressure* also, the death of bone resulting may be but little. In one case, a focus, opened early near the knee, showing staphylococcos pus, called for operation a few days later to drain at the mid-third of the femur, and after weeks involved the hip-joint, without producing anything more than trifling scale sequestra in the shaft of the femur. This limitation is a matter of drainage.

Seventh, after the involucrum is formed, periosteal repair is not good; one gets at least as much from reasonably vascular cut surfaces of new bone as from the periphery, despite the recent allegations of Mayer, who forgets that foreign bodies depress bone-

growth, even if they are of glass, just as bone-plates of steel do in clinical experience.

Eighth, repair power after operation is adversely affected by infection but probably also by exposure. Unprotected bone out in the wound rarely covers well. In part this may be a matter of drying and chilling.

Ninth, repair of new bone that has been long finished, so to speak, is low. Simmons' statement of the poor growth power to be looked for after a year is at least approximately true. Also it is true that repair power is lower in adults. Capacity to repair also seems to cease earlier after infection in adult cases, particularly in and after middle life.

DIAGNOSIS

Any case that shows localized deep bone tenderness with fever, *even without severe pain*, is *presumptively* osteomyelitis.

Œdema may be present or may not. The fact that onset is slow is no bar. History of trauma some fortnight or so earlier is usual though not, of course, conclusive.

Any case that shows an abscess *on* the bone *without clear cause*, even if there is no suggestive history, must raise the question of drilling to the marrow to explore. I have made more mistakes staying out than going in, and have had no case, and have seen no case, of harm from drilling in out of a cleaned-up abscess into the marrow, not a case of introduced infection.

Accurate diagnosis in these cases is still beyond us.

The X-ray is not of much help but it is not true that the X-rays of these cases are "negative." They do show a fogging and a disappearance of the clearly outlined marrow-cavity. They are, however, not easy to read and this appearance may not be clear until *after* the time at which the bone should be drained.

The thing to do, often, is to go ahead and explore, even if the diagnosis is not an absolute certainty. There is here a chance for surgical hysteria. Not a half-dozen years ago, a nationally known surgeon advocated the thorough internal curettage of the infected marrow cavity with gauze strips pulled to and fro. The idea in this is not quite clear!

Osteomyelitis is not a massive marrow embolism but an infection of the marrow which by infection and *consequent internal pressure* deprives the shaft of the bone of nutrition and so determines bone necrosis.

Why one should aid this unfortunate bit of pathology by stripping away from the cortical bone every chance of nutrition and recovery after drainage is not clear.

What one should do, of course, is to relieve the local abscess, relieve the local tension, avert the ischæmic necrosis, save the threatened bone. In other words, *drain!* If one drains in an acute or a subacute case, one averts the catastrophe, one averts massive necrosis and limits the damage to a juxta-epiphyseal infection, to be dealt with *secundum artem*.

Late cases are neglected cases or cases misunderstood because of pathologic or other complications.

The clinical problem as presented may be summed up as follows:

Any tenderness of bone is suspicious.

Any bone tenderness with fever is very suspicious even without pain.

Any abscess about any bone is doubtful.

Any persistent sinus to or toward bone warrants investigation. Often the X-ray will tell more than the probe. Do not *assume* an invasion of periosteum alone in a chronic case any more than in the acute.

Any long continued bone soreness, especially if with well-localized thickening, or with tenderness to percussion, warrants suspicion of localized infection. The X-ray may show a Brodie abscess without a typical history or with perhaps the story of long continued *occasional* lameness as the only complaint. The X-ray, properly read, tells the story. The source of confusion is syphilitic disease. Usually the X-ray will differentiate readily. Syphilis in bone is rarely a destructive process; if it destroys at all it erodes from the periphery. This picture may be confusing as may the rare cases of periosteal sarcoma that give a subperiosteal erosion before obvious tumor appearance. Scurvy in children with periosteal overgrowth may confuse, but this again is not a destructive process. Tuberculosis should be clearly differentiated

by lack of repair power. There is room for confusion between osteomyelitis and that type of tuberculosis with slow progress and unusual regenerative power met with at times in carpus and tarsus. In shaft processes in the first place tuberculosis is rare, the history is different, the clinical picture is different, the X-ray is different, yet a good many cases of sinuses leading to sequestra are still treated as tuberculous, particularly if about the hip. This should not and need not be.

TREATMENT

One has heard too much of the "ideal" operation if by that one means subperiosteal resection, an operation that should rarely be done.

First. Obviously the *ideal* operation is the relief by opening the focus of infection *before* there is bone damage, not always but often possible, wonderfully satisfactory when done early enough. In some such cases one needs only drainage and that for a short time only. In picked cases this is possible even after a week or more from onset of the disease.

Second. The next choice is the early operation while bone damage is but little—trephining, drainage, disinfection—a later cleaning out of small sequestra, and either a return to the Dakin disinfection or resort to the wax technique presently to be described.

Third. In case of a good deal of bone destruction one waits, after establishing good drainage and disinfection, until demarcation occurs. If but part of the shaft is gone, go in and remove sequestra as soon as they are separated. In such cases if an accessible wound is left to granulate, one need give nature no further help, as a rule, save for keeping the wound clean by continuing disinfection.

Fourth. If there be a total sequestrum, of whatever length, then wait until the periosteum begins to show a shadow line of new bone in the roentgenogram and do the subperiosteal operation carefully. At best one has the two triangle ends to fill in; at worst there may be defective periosteal repair at some point and almost a reproduction, a condition not infrequent, calling for repeated repair operations. This operation is not to be compared to the early operation if one can choose. Whether the average result (even in apparently favorable cases) is better with this much vaunted technique than with a later operation after the involucrum is well under way I am not quite sure. The subperiosteal operation is prettier, perhaps no better.

Fifth. In cases first seen in a later stage as most of them are, one has an involucrum of some mass enclosing sequestra greater or less. Obviously the shell is to be opened early, while bone growth is still active, and before too many fistulæ have developed. When it can be done one makes a trough and cleans out sequestra and "pyogenic membrane."

Then comes the question of closure, of filling up the trough. A fair-sized trough will often close up simply under Dakin irrigation, slowly but well. Even a large cavity can be handled with bone wax. Schede's blood clot is obsolete, for reasons. Filling with inturned skin flaps is not at all bad, but often impractical for lack of slack. Turning in a muscle flap (Chutro et al) is a clumsy piece of work, and has not worked for me in the cases where it mattered. It is easy to do in cases that have only a pocket that would heal if left alone. Fat transplants are better, if they have a pedicle. Free fat I have had no luck with in osteomyelitis cavities, well as it takes in most places. Breaking in of the bony sides of the trough to lessen the cavity is ingenious, and sometimes works well. The ideal operation at this late stage, however, is to my mind the removal of the sides of the trough leaving the bottom only and such lateral periosteum (little enough) as may be separable. This I have done often on various bones. It works out prettily, it carries no danger save of fracture[1] (a risk calling for splint protection and bed care for a time), it minimizes the chance of pocketing. I have never done it in an adult case and perhaps it should not be done on very late cases with low repair power, but I have seen no case that refused to repair.

This is the ideal operation, late.

Sixth. In late cases with many, poorly draining fistulæ a removal of sequestra, open

[1] I have had one such fracture in a femur case. Union was prompt, the result perfect.

trough drainage, wide open cleaning of sinuses, Carrel-Dakin to a decent cleanliness, and then a second deliberate operation to start repair, form the best routine.

Seventh. In late cases with open drainage, in cases of the last group after the first operation, and in inveterate cases, often already operated on once or many times, the question of choice of operation is not so simple. One has less repair power to depend on than in earlier months and sometimes very complicated pockets and many fistulæ.

In these cases one may do the very radical thing, as just sketched, provided the field can be laid wide open and thoroughly cleaned.

My best success, however, in this type of case, has been with the bone-wax technique, used not as Moosetig-Moorhof meant it as a permanent filling, but as a temporary protective filling. Given a cavity well drained and moderately disinfected, preferably by chlorinization, one may operate, lay the cavity wide, and treat all of it or such portion of it as is accessible to real cleaning, by immediate disinfection, then bone-wax filling. In this way pockets and troughs may be filled and will often heal even if sepsis recurs in the soft parts in the cleaned sinuses. No small part of the success of this depends on starting with a wide-open bone wound and with a fresh surface to the cavity, disinfecting it most liberally with 95 per cent carbolic for 1, 1½, even 2 minutes, before turning in the alcohol, drying it as well as may be (I have never had a hot-air drying machine), plugging it with wax up to bone level, and packing the wound in the soft parts with alcohol-soaked gauze and keeping it so soaked. Or Dakin's fluid may be used in the open wound over the wax without disadvantage.

Presently the wax is extruded, slowly as a rule, leaving behind it not bare bone but firm granulations. This is the rule even if some pus forms behind it, which usually does not happen. Rarely one clears out the wax, later, after the bone floor is covered with granulations.

This technique has been most generally recognized in treating the small cavities—the Brodie abscesses—in which one may make what I have called a dentist's cavity, firm walled and visible; but I am using it more and more in even the big cavities particularly in the class of cases in which a considerable trough or an end pocket cannot be avoided.

With this method one does not get fresh bone infections, or the troublesome patches of inert, avascular old involucrum at the bottom of persistent sinuses. Repair is slow but steady; the dressings are simple; there is no pus absorption, and the patient can be up and about early. Just *how* this method works is still debatable.

During the winter a year ago we tried out in U. S. A. General Hospital No. 10, a considerable series of chronic bone-pocket infections from old wounds using this technique with various wax mixtures with little to choose in results, which results were nearly uniformly good. Evidently it makes little difference whether one uses the Moorhof wax or the straight wax of the army or Lukens' (Horsley's formula) or the paraffin and oil of sesame originating at No. 10. We happen to have had less good luck with the Beck pastes. Probably all act on the same principle and probably it is the same thing that has proved useful with the paraffin for burns or Morrison's "bipp" for open wounds, namely a protective layer over reasonably clean wound surfaces.

Certainly a wax-layer does protect freshly denuded bone from: (a) air-drying, (b) chilling, (c) re-entering infection from without.

Perhaps these three things are all; given a clean wound perhaps that is enough.

Permanent plugging, or attempts to close the soft parts over wax or over anything else, do not appeal to me, but I am still firmly of belief that the wax treatment has a place and that in the really old cases I can do better with it, or rather, do with less failures, than with any form of operation even reinforced with careful Dakin treatment.

At Hospital No. 10 we found the cases under Dakin treatment alone did well for a bit and then often left us at a standstill, active repair ceasing. In some cases we chose a time of minimal bacterial count, re-cleaned and filled with the paraffin-wax. We got results but not as uniform results as in the cases first cleaned to bone then sterilized with

carbolic, and waxed. Granulations are not easy to get really aseptic after all.

In the few cases in which sheer lack of repair power is the trouble we are rather stumped today. Bone grafts are often out of place because the wounds are septic, or if healed, then so liable to recurring sepsis; whole plastics are rarely useful unless one excepts the cross transplants of fibula for tibial defect. Fortunately these cases are rare in the spontaneous osteomyelities cases unless one does the subperiosteal operation.

Whether we may some time feed the languid bone with bone or lime or magnesium to stimulate the jaded growth, time alone can tell. As I have already said I am an optimist for the moment at least, about this line of endeavor.

INFECTED JOINTS

Here too we are at the beginning of a new era. Only of late have we begun. It is only five years ago that I read a paper, perhaps a pioneer paper, on the radical early disinfection of infected joints, ignored at the time, reprinted in the *British Medical Journal* in 1917, as people began to get the point of view. Previous work in continuous disinfection of the closed joint, as in Krause's iodoform injection and Murphy's formalin-glycerin, and even the results of the ether lavage of the French surgeons, seem not to have brought out the point; namely the long resistance of joint structures to most infections.

The operations and the one accidental autopsy finding in one recently cleaned joint of my series emphasize the slowness of simple infection (when there is no tension) to penetrate below the surface layers.

In the septic joints associated with osteomyelitis, for instance, my cases reported show how readily the infection may be overcome as a rule. Our old experience shows the lamentable result of the usual form of drainage both as to deaths and as to ruined joints.

If there is damage to soft parts or bone associated with the joint infection, disinfection by irrigation with primary closure is not usually practical, but war experience has shown that there are two ways, disinfection with Dakin's leading up to secondary closure or to healing by granulation and the Willems treatment of free incision with mobilization. In face of the results of these methods one can no longer say that a drained joint is a ruined joint, without making exceptions.

How good are the results of the mobilization treatment alone? I cannot say from my limited experience. It would seem that this method gives free drainage and a chance for the filling up of the joint rapidly with granulation masses. We have long known that there was no muscle spasm holding a *drained* septic joint. Now we know that if we encourage, as well as allow, motion, some sort of joint results, probably without a very definite joint cavity but with useful motion. Unfortunately the war cases, such as those in Metcalf's excellent paper on wounds of the knee, include only a few followed through. They do establish, however, the harmlessness of the procedure, the promotion of drainage, and apparently the lessened liability to pockets (as in the popliteal space) outside the joint and the possibility of good results. Part of this I can confirm—what I do not know is the chance of complications. I have had one case with secondary total necrosis of a previously intact patella under this treatment and one case in which the healing was so slow that adhesions were solid and a later *brisement forcé* necessary, though successful, after closure.

I am not yet clear just what sort of a joint results, though this does not matter.

Some eight years ago I drained an infected knee with the U incision laying the patella up on the thigh. The joint filled up with granulations, flush with the surface. A secondary operation showed smooth enough cartilage beneath granulations, so I prepared a fresh surface, disinfected, replaced the patella and sutured the tendon, drained for 24 hours, mobilized, and got a strong knee with 45 degrees of motion.

This is the same sort of thing, probably, that one gets by the Willems method, the same thing that I have recently so obtained in two cases and am hoping for in a third recent case.

What should be our routine today in infected joints?

In fresh cases without bone lesions wash out very thoroughly—I still use corrosive 1:15000 following salt solution—and suture the capsule water-tight, leaving the outer wound open, mobilizing after a few days. There is a moderate effusion for a few days, then return to a joint either normal or with few adhesions.

In cases in which suture is impractical, clean and use the Dakin treatment—doing a secondary suture if the count quickly comes to justify it.

In case of failure mobilize as the joint heals up, making sure of very free drainage the while, retaining all the motion one can.

At worst, and there will be a few cases, lay the joint wide open with multiple incisions, use Dakin solution, mobilize only when the vital danger is past, let the joint fill with granulations, and save what one can in motion, doing secondary operation as needed without immobilization.

I have lately had a case of arthroplasty of the elbow with a free fat transplant that was lost late, without frank sepsis, in which this routine of early disinfection and later mobilization before healing has given normal forearm rotation and about 50 degrees of hinge motion, and two primarily infected elbows too late for washing that have done admirably.

Here again we have a practical joint if no real joint—a distinction of no importance.

The question that with me is still open is whether it *may* not be wiser to take a chance and do frankly what Willems did; open wide and mobilize to the limit from the start, with or without the help of Dakin irrigation. So far I have done this but once—with success in the one case. I have not met the answer to this. Probably only considerable experience will decide whether this very radical handling is always wise.

So far we have considered what may be done to save a joint and to save a mobile joint. Not all, of course, can be saved with motion; grant me a moment to consider the possibilities in late cases with adhesions limiting motion.

Arthroplasties of an effective sort are apt to be impractical on account of the broad scarring about the joint with the great chance of slough and sepsis and the difficulty in securing covering without tension so that even without sepsis one loses fat by liquefaction and drainage.

Similar limitations circumscribe the arthrotomy operation with oil injection and firm capsule closure done a good deal some years ago by Brackett and others. These operations are ideal only with clean traumatic adhesions and the gonococcus and non-suppurative septic type.

Failing these, are we helpless? I think not in any case that can be broken up or stretched. *Brisement forcé* has a place still, or again, in our work, but it must be a *brisement* carefully done, supplemented by fleeting fixation in the optimum position for the given joint, followed by early, careful heat and massage and *active* not passive movements.

Repeated breaking-up does nothing, but after one session later mild stretching under gas is not contra-indicated, with more physiotherapy to follow.

Realizing that pain is the bar to retaining motion once gained, I have tried out once with some success the effects of enduring anæsthesia with quinine and urea solution in and about the joints. This should render late manipulation easy. Reaction of tissues except as expressed in pain is not usual after such *brisement*. This is good theory; someone else expert in local anæsthesia may perfect a real working technique before I do.

In closing let me recognize frankly that this is not a record of cases or statistics but a general review. May I hope that there has been a summation of what means we have at hand for the fighting of bone and joint infections, a partial classification of methods according to indications, new at least in part, an indication of needed lines of study and of interpretation of work already done, and a few suggestions as to methods to be worked out and tested for good or bad by you, or by me, or another.

CLINICAL CONSIDERATION OF OSTEOMYELITIS[1]

By A. J. OCHSNER, M.D., LL.D., F.A.C.S., and D. W. CRILE, B.S., M.D., Chicago

IT has seemed worth while to consider osteomyelitis from the standpoint of the clinician because circumstances have favored us with an opportunity of observing an unusually large number of cases suffering from this affliction.

My observations began 34 years ago when I served as assistant to Professor Moses Gunn who treated a very large number of these cases. Following his death, I served as chief assistant to Prof. Charles T. Parkes for a period of 3 years, and after his death as chief assistant to Professor Nicholas Senn for a period of 4 years. Each of these surgeons had a great number of cases of osteomyelitis; hence my special interest in this subject.

In my own practice at the Augustana Hospital during the 20 years from January 1, 1899, to January 1, 1919, I have treated 301 cases of osteomyelitis, so that the following views are based upon the treatment and observation of a sufficiently large number of cases to be worthy of consideration. My assistant, D. W. Crile, served in France and England for a period of 3 years during the recent war where he had an opportunity of observing several thousands of cases of osteomyelitis due to gunshot and shell wounds and he likewise is interested in the subject.

Osteomyelitis is a disease, inflammatory in nature, involving bone and having its origin practically always in the medullary tissue, although at times it may originate beneath the periosteum (1), and also as Lejars (5) says: "Frequently, there are two foci; one, subperiosteal, and one, in the medulla."

Osteomyelitis may be subdivided into the acute infective type, the subacute infective (occurring during the separation of sequestra and including rarifying and condensing processes in the bone), and chronic osteomyelitis in which the infecting organism determines a further subdivision into pyogenic, tuberculous, or syphilitic.

As a matter of fact the division of infective osteomyelitis into an acute, subacute, and chronic stage, is purely arbitrary, and often can be accomplished only with the greatest difficulty, since the disease is a progressive one. However, as a general rule, the acute stage may be said to occupy the period when a general systemic reaction exists characterized by fever, toxæmia, an increased pulse-rate, intensive pain, always located near the affected part and generally being diffuse over the entire neighborhood. The subacute stage may be said to begin when the toxæmia has been overcome and suppuration still exists. The chronic stage constitutes that period in which the bone cavities exist.

It is possible for the acute stage to be absent, clinically, so that when first discovered the disease may be subacute or it is possible for both the acute and subacute stages to be negative clinically so that when first discovered, the chronic stage exists. This, however, is due to the fact that the early stages were looked upon as rheumatism, growing pains, or neuritis.

Clinically, the tuberculous and syphilitic forms should occupy a separate classification. They are chronic; although each may be subdivided into an early and a late stage of the disease. Their course, pathology, and treatment are quite different from that of the pyogenic forms so that they will not be considered at this time.

ANATOMY

The disease depends for its location and characteristics upon the fact that bone is a rigid and peculiar structure composed of a hard, sparsely vascularized cortex and a soft highly vascular core (the medulla), and a circumferential vascular covering, the periosteum.

All bones contain these three structures. However, they are present in varying proportions. The long bones such as the femur, tibia, fibula, humerus, and the bones of the forearm contain the greatest proportion of hard tissue and in these the medulla is a true core.

[1]Read before the Chicago Surgical Society, February 6, 1920. (For discussion see p. 305)

This core is transformed into a spread-out, flat structure in the flat bones but occupies the same relative position to the cortex. If one saws through a bone, the outer layers are found compact while the medulla is found to be composed of an interlacing of thin spikes and spicules having attachment to the cortex. The difference in these two portions is pronounced, the cortex being composed almost entirely of solid matter while the medulla contains large spaces between the spicules, in which there are fat, marrow cells, thin walled blood-vessels, and a considerable amount of blood. However, close inspection shows that the union between these parts is not an abrupt one and that it is often impossible to say at what point the marrow becomes the cortex. However, in the femur and humerus and to a less extent in the tibia a definite medullary cavity exists in adolescent and adult life—the shaft of the bone being hollowed out more completely than the ends. This cavity contains true medullary tissue: fat, lymphoid cells, and hæmoblastic centers. On breaking a long bone transversely, one is able to see that even the densest part of the femur is pierced by tiny canals each containing a blood-vessel and the larger ones containing lymphoid tissue. These canals are smallest in diameter directly beneath the periosteum where they are about 1/1000 of an inch in diameter and as one progresses toward the medulla, they gradually increase in diameter until at the place where the cortex merges into the medulla they are about 1/200 of an inch in diameter. In the medulla itself they attain a very much greater size (1½). These canals are nothing more than the tubes in which the blood-vessels lie and are called haversian canals after Clopton Havers an English physician of the 17th century. Each haversian canal is surrounded by a series of concentric columns of bone which columns are divided one from the other by concentric rings of single, little, thread-like processes which communicate from one cell to the other and with the central tube of the haversian canal. These cells are called the lacunæ and their thread-like processes are called canaliculi. The concentric layers of bone which are really fused into one column and the adjoining columns which are fused together making a continuous plate, are called lamellæ. Between the lamellæ and between the concentric groups of lamellæ, one finds here and there irregular spaces which evidently are a result of the absorption of hard bone. These spaces are called haversian spaces. Virchow (2) says that each of the cells occupying the spaces between the lamellæ is nucleated and Kolliker (3) is authority for the statement that some of the processes from these cells are connected with the periosteum and undoubtedly they also communicate freely with the blood-vessels of the haversian canals.

It will be seen from this survey of the structure of bone that neither the cortex nor the medulla should be considered a crystallized or an inanimate substance. As a matter of fact one has a better conception of the true nature of bone, if he considers it as a deposit of organized mineral salt between the spaces of a finely-branched system of blood-vessels. Not only is the entire bone permeated by canals containing blood-vessels and living cells absorbing nourishment from these blood-vessels, but lymphatics also most probably exist (4).

The periosteum is also very vascular and is a rather coarse, fibrous membrane particularly where it affords tendinous insertions. It can be divided microscopically into three parts; the one in immediate contact with the cortex of the bone, consists of strands of fibers containing quite a number of granular corpuscles particularly in the young animal. These corpuscles are precisely the same as those one finds bordering the haversian canals, and it is possible that they are similar to the bone corpuscles found in the lacunæ.

Surrounding this division of the periosteum is a layer of elastic fibers, and the outer part of the periosteum again becomes composed of white, fibrous strands containing many blood-vessels which ramify and prepare to enter the openings of the haversian canals of the cortex before they penetrate the elastic layer of the periosteum. These blood-vessels in the periosteum appear to have some muscular tissue in their walls but the vessels which enter the bone are devoid of muscle (except

the nutrient artery). The blood supply of the bone comes also from nutrient arteries which generally enter the medullary cavity by a hole running obliquely through the compact cortex, and in the long bones the artery generally enters near the middle of the shaft. There are generally a few nutrient arteries entering the bones near their ends, but for the large part the foramina which one sees near the end of bones are for the emission of veins. There are two main nutrient arteries for the femur.

The course of blood through a bone. Arterial blood enters a bone through two routes, the most evident route being via a nutrient artery which after it reaches the medulla, sends blood both up and down the bone, rapidly dividing into an arborization, the branches of which are short, emptying quickly into comparatively large venous spaces. The other route of arterial blood is via the periosteal vessels, the arborization having already occurred in the periosteum—when following this route the arteries are lost track of almost immediately and capillary vessels conduct the blood through the haversian canals in which it may be said to become venous at once. It seems that this periosteal blood penetrates a very little distance into the bone, compared to the distance that the medullary prenutrient supply does. One can readily see how this comes about when one remembers that the haversian canals have their smallest diameter near the circumference of the bone. The blood issuing from the cut surface of live bone always exhibits the characteristics of venous flow, except when the nutrient artery itself is cut. For these reasons arterial blood, on entering the proper bony circulatory system, loses much of its impulse and becomes static. One may compare the entrance of blood into a bone with that of the entrance of a stream of water into a tank.

Foci of infection. Therefore, any organisms contained in the blood and brought by the blood to a bone, find their first opportunity to rest at the point where they enter the interosseous circulation. This point may be either directly beneath the periosteum or in the medulla at the point where the branches of the nutrient artery enter a blood-space. With the stasis of the blood, the bacteria settle and begin to multiply, undisturbed by a blood current. In this way bacteria which are not virile enough singly or two or three together to make a home for themselves in a more active tissue, are enabled to begin an infective process in the bone. Having multiplied to sufficient numbers, they excite a little inflammation in the delicate cells lining the blood space. These cells swell and leucocytes and fibrin accumulate, shutting off this blood space from the remainder of the circulatory system. This can occur easily because bone encloses the blood space in all directions except its entrance and exit, so that swelling must occur only toward the cavity of the space and cannot occur circumferentially. From this little focus toxins and young bacteria disseminate, reproducing and extending this same process. We know that this is true from clinical experience, because the primary focus in acute osteomyelitis is practically always in the shaft and corresponds with the arborization of the nutrient artery as a general rule, occurring most frequently at the places where stasis is greatest, e.g., on the diaphyseal side of the epiphyseal lines and at the cortex of the bone. At both these places the blood-vessels are narrow, and the blood current very sluggish.

It is true that in many cases there seems to be a simultaneous involvement of the subperiosteal region and the medulla but while this is possible it seems most likely that the process begins in one or other of these locations and rapidly extends through the communicating blood spaces from the medulla to the subperiosteal region, or vice versa. Lejars has noted the frequency of this occurrence and advises that whenever an accumulation of pus is found beneath the periosteum, it should be opened widely, even though no other indication exists—for a medullary abscess is undoubtedly present.

BACTERIOLOGY

Almost any organism may be found in osteomyelitis. By far the large majority of cases are due to the presence of the pyogenic cocci (6), and the staphylococcus is the organism most frequently found. Streptococcus

in all its strains, the typhoid bacillus, the pneumococcus, the colon bacillus, the Klebs Loeffler bacillus and others, have all been found in this disease, so that it is quite evident that the disease is not dependent on a specific organism. Neither is there any proof that any particular strain of organism exercises a selective action for the bone marrow.

INCIDENCE OF DISEASE

Osteomyelitis occurs most frequently in the adolescent boy. In a series of 104 cases at the Copenhagen Hospital, it was found that boys were affected three times as frequently as girls, that the bones were affected in the following order: femur, 39; tibia, 31 and humerus, 9; fibula, 7; radius, 4 and ulna, 2. Our experience confirms this sequence.

It is interesting to note the greater frequency of the femur since this bone has more nutrient arteries entering it than any of the other long bones. The long bones are much more frequently involved than any of the others. The infrequent incidence of acute infectious osteomyelitis in the vertebræ is interesting when compared with the incidence of tuberculosis of the vertebræ, and in this connection we would like to point out that perhaps there are many cases of the disease in this region which are incorrectly diagnosed until spinal meningitis is manifested and as such proves fatal.

There is no doubt that trauma predisposes to the localization of the condition at the site of bony contusion. This is the true explanation of the greater frequency of the disease in boys, although the latter are also more subject to exposure.

The disease often follows exanthematous fevers, typhoid fever, pneumonia, acute pleurisy or the presence of a hidden focus of infection anywhere in the body. When following these diseases it is plainly the result of a hæmatogenous transportation of the germ. It is believed that the presence of infected tonsils, infected teeth, disease of the middle ear or sinuses, or chronic appendicitis, are often responsible for the origin of the bacteria causing this disease. In its acute stage, it sometimes is only a manifestation of a septicæmia or a pyæmia, and in these most serious conditions, multiple foci often exist. However, the disease does not necessarily indicate this grave condition.

PATHOLOGY

Early in the acute attacks the medulla is congested centering about the focus of infection. The periosteum overlying the involved region is hyperæmic, pinkish in color, and heavy with œdema. It feels tense and rubbery, but there is no actual pitting as one sees accompanying inflammation in the subcutaneous tissues. On separating the periosteum from the bone, bleeding is more evident than it is in the normal condition, indicating that the tiny blood-vessels which enter the haversian canals from the periosteum are dilated in their attempt to carry an extra amount of blood to the injured area. One notices this hyperæmia in the cortex itself in some cases when the marrow cavity is opened, for the congestion is quite marked. The normal fat tissue which ordinarily will not flow has a melted appearance and oil may even be seen oozing from the marrow spaces. At this incipient stage one may find no pus whatever, and it is during this time that operation accomplishes the most good, since if the medulla is well drained at this time, the infection may be checked absolutely so that medullary and cortical necrosis do not occur at all. One may discover this stage on the first or second day but as a general rule, abscesses are present within 24 hours of the onset. The abscess centers about the initial infarct and, if not seen until considerable pressure has been developed in the medulla, secondary abscesses will be found often at quite a distance from the primary focus. It is not at all uncommon to find the entire medulla of the bone full of pus. At this stage of the disease which may be encountered at any time after the first 12 hours, one frequently finds subperiosteal abscesses as well, which have developed from the medulla through the haversian canals to the subperiosteal region or vice versa.

Epiphysitis: The epiphysis becomes involved in 12 to 15 per cent of the cases and between the second and seventh day of the disease. When the epiphysis does

become involved further growth of bone from the epiphysis may be arrested particularly, if actual separation has occurred.

As a general rule the disease is limited to the diaphysis, the epiphyseal cartilage acting as a block against extension of the process into the joints. And also the close adherence of the periosteum at the epiphyseal lines checks the extension of subperiosteal suppuration toward the joints. This in counter-distinction to the characteristics of tuberculosis. However, the joints proximal to the acute infection commonly show distention, the distending fluid being a protective outpouring of lymph into the synovia, and the fluid in these joints is very seldom infected. At times this fluid may even show traces of blood and the synovia are œdematous and hyperæmic.

Sequestration. After frank pus has appeared in the medulla, one hardly expects to prevent the necrosis which generally follows osteomyelitis. The inflammatory pressure which develops simultaneously with pus in the bones causes a shutting off of the blood and nourishing lymph to certain parts of the involved bone. Thus these parts die and after varying lengths of time are separated from the living parts. The separation of the delicate medullary bone occurs more quickly than does cortical sequestration. Thus medullary sequestra may be loosened after 2 weeks while the cortical sequestra generally take from 4 to 8 weeks in separating. The separation seems to be accomplished through the activity of certain marrow cells termed osteoclasts whose function it is to destroy all unnecessary bone. However, it seems that the presence of pus itself has some solvent action upon dead bone and this action is demonstrated by the gradual disappearance of small sequestra which are constantly bathed in pus. This solution of sequestra is a long and slow process which may be aided by chemical stimulation but surgical removal of sequestra after separation is our practice.

Character of pus. As the acuteness of the process decreases, the character of the pus changes gradually, until in the subacute and chronic stages the pus becomes a thin, serous fluid lacking the milky rich appearance of the pus found in the acute condition. The very initiation of the process, however, is generally accompanied by a very thin, almost clear exudate, and this is particularly true when the offending organism is the streptococcus.

Repair. Reparative processes begin simultaneously with the formation of sequestra which may be single, multiple or the entire shaft may become a sequestrum. Inflammation stimulates the bone-producing mechanism, and it is not long until new bone begins to appear beneath the periosteum. It seems that this does not come from the periosteum itself but from bone element left clinging to the periosteum and nourished by the vessels of the periosteum. After 3 or 4 weeks, the periosteum begins to have a brittle feel much like the crackling of delicate tissue paper, and gradually the layer of new bone nourished by the periosteum assumes a definite thickness and gradually loses its property of being molded until after 8 or 10 weeks a definite shell of new bone surrounds the old dead bone. This new involucrum is poor in quality. It is honeycombed with spaces through which pus escapes from the neighborhood of the enclosed sequestrum or sequestra. There may be only one small hole through the involucrum but where multiple sequestra are contained, many cloaca are found and often the new shell of bone is so fenestrated as to resemble a very imperfect lattice work.

The new involucrum may be very imperfect in its reproduction of the original bone. Particularly is this the case when entire portions of the shaft have been destroyed and the limb has not been kept in its normal shape by orthopedic appliances. This most often occurs in the upper arm and thigh since in these parts there is only a single bone. In the leg and forearm where a second bone generally retains its shape, deformity does not so readily occur.

New bone is also formed from the medullary region, but this bone is not so important pathologically since from its position it cannot surround dead fragments, and therefore is more homogenous and of better quality than is the subperiosteal bone.

Granulation tissue is more generally found growing from the medullary region than from the periosteal region, and it seems that the chief efforts from the core are directed toward the removal and destruction of sequestra and bacteria, while the efforts of the circumferential tissues seem to be directed toward the reproduction of supporting bone. So far as the pathology of the chronic stage is concerned, it makes no difference whether the acute process has been cut short by surgical intervention or whether nature has accomplished the overthrow of the acute infection. In either case the successful outcome will have been accompanied by the creation of an exit for the pus, so that in the later stages one sometimes finds sinuses leading from the sequestra to and through the skin. If these sinuses are the result of the spontaneous evacuation or of insufficient incisions through the periosteum in draining the abscesses they may be very long and devious. An abscess arising in the medulla at one end of a bone may not find egress from the interior of the bone until it reaches a point quite a distance from its origin. Here it breaks through the cortex to the subperiosteal region where it may travel still further from the original focus before it makes exit through the periosteum into the fascial planes overlying. This is most likely to occur near the insertion of a tendon and from this point the pus generally travels along the tendon sheath toward the surface where, after a superficial abscess is formed, rupture occurs. Frequently the spontaneous sinus has a direct course to the surface and when this is true it resembles the sinus resulting from surgical drainage. In either event the sinus in the chronic stages is lined by granulation tissue. The granulations which spring from the interior of the involucrum together with those that line the sinus pour out a thin chronic discharge. Often the deeper granulations assume characteristics which have led French writers to call them "fongosites." These "fongosites" are overgrown, poorly nourished, œdematous masses—when cut they do not bleed as healthy granulation tissue does. They have a sickly gelatinous appearance and almost always indicate the presence of a sequestrum. When the sequestrum has been dissolved, discharged, or removed, the cavity of the involucrum fills slowly and incompletely with these granulations depending from the lining membrane of pseudo periosteum. These involucral cavities persist for great lengths of time and seldom fill in with healthy tissue. As time goes on the involucrum becomes very dense, and this is particularly true where there have been multiple small cavities and sequestra while the bone at a little distance suffers an atrophy. These two conditions may be seen in the same bone or one or the other may be present alone. The sclerotic condition is termed condensing osteitis while the other is rarifying osteitis.

The pathology of the chronic condition which we have described is generally absent altogether following thorough primary surgical interference, but these changes are so frequently present they must be described.

In considering the pathology of this condition, one must also remember that the overlying soft parts may suffer changes dependent upon infection, disuse or deformity, and likewise contiguous joints may suffer from actual infection or secondary reactions.

SYMPTOMS

Intense pain is the most striking symptom of acute osteomyelitis—pain so severe that the patient's perception of one's intention to touch the limb elicits agonizing shrieks. In severe cases the vibration of a bed from people walking near by causes pain and the slightest motion of the affected limb is intolerable. The pain may be preceded by, but generally precedes, a high fever, a rigor or a succession of rigors, general toxæmia, and sweating. Soon the affected limb becomes swollen, heavy, and inflamed; the swelling is generally diffuse, as when the femur is involved the whole thigh becomes tense, red and tender. In the leg or forearm the œdema is apt to be most pronounced over the affected bone. The joints are usually not swollen nor tense in the first few hours but may rapidly fill with serum and result in the appearance of an arthritis; in these cases the limb may be held in the typical positions of the various arthrites.

The temperature rises acutely to very high levels 103° to 105°, and is of a continuous type with little variation between morning and evening. The patient is generally unable to sleep. The pain is not definitely localized but involves the entire limb. The pain becomes worse on lowering the limb, as one would expect since in this position congestion is increased and, therefore, pressure on the nerves is increased.

When the bone is involved subcutaneous tapping on it at a distance from the focus will cause pain at the involved area. In case of an abscess or before an abscess is formed, induration may be found over the site, particularly when the subperiosteal focus is present.

In the less acute types the pain is of a constant character, described as an aching, located in the bone, and resembling the so-called growing pains. These cases occasionally show a slight febrile reaction, present one day and absent for an interval. Sometimes the patient will refuse to use the limb as after use, the pain increases. The subacute type may or may not be painful. There is generally an occasional spell of fever with malaise in the part. This spell may be precipitated by changes in the weather or overexertion. The surface of the bone may show nodules and irregularities.

The chronic type without sinuses is seldom discovered in boys and girls and in older people often simulates and is probably diagnosed as chronic rheumatism. It is this type that includes the circumscribed bone abscess and bone-cysts. The chronic stage of the acute disease is almost always made evident by the presence of a discharging sinus.

DIAGNOSIS

Acute infective osteomyelitis must be differentiated from acute rheumatic fever which can usually be accomplished by noting that the affection is extra-articular. When contiguous joints are swollen secondarily, however, the differentiation is not easy. When this condition exists, tapping over the bone at a point farthest from the joint, may cause pain in the bone, while in an acute rheumatic joint, such tapping may be painless *unless the joint be moved*. The presence of a single synovitis argues against acute rheumatism. One finds too that the skin overlying the joints is less red and œdematous when the synovitis is secondary to osteomyelitis. The general prostration, while it may be great in both the diseases, is often greater in osteomyelitis. Sometimes the joint contiguous to the osteomyelitic bone can be moved painlessly, but this is rare; one must always differentiate between acute osteomyelitis and an early stage of infantile paralysis. At times this is very difficult. The presence or absence of stiffness of the neck is very important in this differentiation, and whenever two limbs are involved, one can safely rule out osteomyelitis, as the disease rarely begins with a double focus except as evidence of a general pyæmia. The acute arthritis of infants generally occurs in the hips and knees and is most often found in nursing babes and may be associated with a gonorrhœal ophthalmia or vaginitis (8). In very young children one must always bear in mind the possibility of the presence of scurvy, which can be readily recognized because it affects many joints.

Acute arthritis deformans, especially when occurring in children, may be very difficult to differentiate. Generally the arthritis is multiple, however, the prostration not nearly so sudden, the temperature not nearly so high, and the joints less tense. All these conditions, however, can be excluded by the exact localization of the process outside the joint, and generally on the diaphyseal side of the epiphysis. The condition should not be overlooked in its earliest state when it is usually considered a strain or sprain or contusion, since a history of trauma is frequent.

The X-ray is of little or no value in the diagnosis of the early acute stage except in a negative way, since it may confirm the presence of periosteitis, tuberculous or syphilitic disease, or fractures; when medullary abscess formation has occurred, an excellent X-ray plate may demonstrate the condition but the diagnosis should be confirmed by one who is thoroughly familiar with the shadows seen in this condition, since they are often very faint and illy defined. The

later stages of the disease when bone cavities, cysts, and sequestra exist are readily detected by the X-ray.

PROGNOSIS

The prognosis of the acute disease is always grave. When death occurs it is generally during the acute condition, and one finds pyæmia, infarcts in lungs, kidneys, liver, brain, and vegetative conditions of the circulatory system as well as multiple foci of infection. These conditions may be the result of an unattended osteomyelitis but often are concomittant evidences of hæmatogenous infection from some common area.

Early diagnosis with immediate surgical treatment modifies the gravity of the condition considerably, but one should never predict that a limb with unimpaired function may result.

Often when the focus is virulent and extensive and early treatment has been neglected, when the general reaction is extreme, (the type of case which appears to have been "hit by a sledgehammer"), amputation has been recommended as offering the best hope of recovery. In our experience this extreme measure has never seemed indicated, although patients have frequently been sent to Augustana hospital for this last hope. In these cases it has always been possible to change the condition by laying open the periosteum and overlying soft tissues, applying an enormous hot moist boric acid and alcohol dressing covered with a large rubber cloth which serves the purpose of retaining heat and moisture and at the same time acting as a splint, and by applying a therapeutic lamp over this dressing. In a small group of very severe cases it is advisable not to chisel open the medullary cavity of the bone at the primary operation.

With early and thorough surgical drainage one may not expect the process to spread into the neighboring joints, even though synovitis already exists in them. When the focus is close to the epiphyseal line, separation of the epiphysis may follow with the resultant loss of the power of growth from that end of the bone.

At times the extreme virulence of the disease results in the destruction of the osteogenetic powers of the tissues so that the bone will not regenerate. Rarely, the opposite result obtains, i.e., bony overgrowth follows the chronic type.

With early surgical intervention within the first few hours of the disease and in the absence of pyæmia, the focus being well away from the epiphyseal line, one may expect recovery with a functioning limb even in extremely serious cases after a long period of disability and with the remote prospect of several secondary operations for the removal of sequestra and for the obliteration of the sinuses.

TREATMENT

Acute infectious osteomyelitis does not seem to have been recognized until comparatively recent times, the explanation probably being that the abscesses finding their way to the surface, obscured the deep pathology and the cases were treated simply as very grave attacks of boils.

The treatment of the acute condition so commonly practiced until recently with poultices, blisters, fomentations, sedatives, cupping, antipyretics, salves, and ointments or manipulation and the healing arts, should be most heartily condemned. The only proper method of treatment is surgical drainage, splitting and reflecting of periosteum over the entire distance and at least 2 centimeters beyond and on each side, and opening the medullary cavity freely in the area involved. Combined with or following this, the part should be immobilized by splints so arranged that dressings can be done without disturbing the splint. Fomentation in the form of hot moist dressings seems a valuable adjunct to this procedure and any of the above mentioned remedies may be employed as accessories without harmful effect except treatment by manipulation. The use of therapeutic lights over the limb is a very valuable adjunct to drainage as they supply heat without the necessity of disturbing the limb. It also seems that the heat waves produced by means of electric light are more penetrating than those produced by the application of ordinary fomentations, hot water bags, and electric pads.

OPERATION

The patient is anæsthetized, the limb is cleaned and painted with tincture of iodine. The incision is made down to the periosteum avoiding the arterial regions and the nerve-trunks and placing the incision so that it will drain in a dependent fashion without pocketing. The periosteum is freely incised in a longitudinal direction, and if it is not already separated from the bone by the presence of a subperiosteal abscess, it is raised by scraping it from the bone by a sharp rugine such as Ollier devised. The blunt periosteal elevator should not be used nor should the periosteum be stripped roughly from the bone. A sharp, thin bladed chisel serves the purpose admirably, handled with great accuracy and gentleness.

Rough treatment would result in leaving the osteogenetic elements on the bone and would leave the periosteum impotent to produce new bone. A hole is now made through the cortex with a trephine or a drill or by chisel and mallet, great care being taken to avoid undue jarring of the bone before the operation is begun or during the operation. It may be necessary to make several holes through the cortex although this is rarely necessary if the point of greatest tenderness is carefully located. In the very early stages one may find no frank pus whatever but the marrow will be oily, serous and œdematous-looking. When this condition or the presence of pus is discovered, a large slab of cortex should be removed, leaving the remaining bone in the shape of a trough. One should chisel sufficient cortex away in both directions from the focus that he may be sure that no secondary focus remains undrained.

The further advantage of this procedure is that any incipient focus, too early to be detected grossly, will be nipped in the bud and will not progress to a destructive stage. The marrow or the exposed area should be removed with a curette and the walls of the cavity remaining may be washed with an antiseptic solution. For this purpose carbolic acid (5 per cent) seems very efficacious. In virulent infections, pure carbolic acid may be used, applied on a cotton swab and allowed to remain from 2 to 5 minutes. After this time it should be diluted with alcohol and the cavity thoroughly washed out with alcohol (95 per cent). In place of using carbolic acid, alcohol alone may be used or ether may be used and of late Dakin's solution has come into favor for this purpose. Tincture of iodine is excellent. The use of various antiseptic pastes does not seem so successful in the treatment of the acute stage, although the bismuth, iodine, paraffin paste seems to have a favorable effect. The cavity may be packed with iodoform gauze or plain gauze to prevent the accumulation of a blood clot after operation. The presence of clots during the acute stage is dangerous and may lead to continued suppuration. The use of Carrel's treatment seems to give good results. Stewart and McCurdy declare that 3½ per cent iodine is the best antiseptic and that packing interferes with the formation of a blood clot, in this way interfering with bone repair. It is most likely that the cases in which a blood clot is desirable, are not at all the type of case that we are considering since the presence of blood clot in this class of cases almost invariably leads to further septic developments. The wound is left open.

Rosenberg says that streptococcus and pneumococcus epiphyseal suppuration often heals spontaneously and that the treatment in nursing infants should be limited to the opening of abscesses (10). He may, however, have confused the acute arthritis found in infancy with an acute osteomyelitis. One should hesitate in making a diagnosis of osteomyelitis in suckling infants for this reason. In my own cases of osteomyelitis in infants the results have been amazingly good following simple incision.

It seems that Lejars and Robert LeConte (11) agree that it is never expedient to incise the periosteum only but that in all cases of periosteitis in the adolescent, it is wise to expose the medulla. If no medullary pus is found little harm has been accomplished while if a medullary focus has been neglected great harm may ensue. My experience has borne out this plan except in the very violent cases described above. (A. J. O.) LeConte favors the early removal of all bone and marrow involved and says that regeneration will occur if opera-

tion has been done early. This corresponds with the work done by E. H. Nicholls, of Boston (12), who, writing in 1904, thought that the periosteum itself deposited new bone after this operation. There can be no doubt that new bone is generally of good quality, reproducing the shape and function of the bone which has been removed. This is particularly true before the ossification of the epiphyses. The bone-forming elements which remain attached to the periosteum are very active at this time of life. It would seem that in order to understand these results, one must believe that inflammation of the bone loosens the bone-forming elements from the periosteum.

Our observations have convinced me that it is never proper to remove the shaft of a bone during the acute stage of osteomyelitis before an involucrum has been formed, because the resulting arms and legs have been infinitely superior in all cases where there has been a late removal of the sequestra.

Based on the experience of handling many thousand cases of traumatic osteomyelitis during the great war, it would appear that when complete subperiosteal excision of a section of shaft is done within a few hours of inoculation, regeneration occurs with more difficulty and more often fails to occur than if the same operation is performed later. In traumatic osteomyelitis, excision of a section of shaft bone after inflammation has manifested itself by congestion and thickening of the periosteum, is hardly ever followed by failure of regeneration by the formation of subperiosteal callus. This is particularly true where the bone-scraping technique of Ollier has been followed as described by Leriche (13). When this technique has been skillfully employed, even before the periosteum is inflamed, regeneration almost invariably occurs. These facts argue that the scraping of the bony cortex and inflammation in the same region result in leaving bone-forming elements adherent to the periosteum.

This explanation of the question makes it clear that subperiosteal resections of bone in acute infectious osteomyelitis are not to be feared provided operation is never performed in this condition before the appearance of inflammatory symptoms. This simple fact, i. e., that inflammation always preceded operation in this condition explains the regenerations which Nicholls so fortunately enjoyed but which he attributed to the periosteum itself.

The work of Nicholas Senn, on the other hand, based on the classical experiments of McEwen (14), gave remarkably favorable results. He did not favor the excision of the entire shaft at an early stage but advocated the operation providing radical drainage, leaving a shell of bone to be dealt with as indicated at a subsequent operation. Nicholls agrees with this idea when the disease is located in either the femur or the humerus, since these bones cannot be excised without considerable deformity and shortening resulting. In the case of one of the bones of the leg or forearm, its fellow serves to maintain the length and shape of the limb so that this element does not enter into the question so seriously as it does in the thigh and arm. Taking all things into consideration, it seems that the best treatment of the initial stage of the disease is immediate incision through the periosteum, thorough exposure of the medulla, leaving enough supporting cortex to prevent deformity and in such a shape as not to interfere with drainage and leaving a layer of bony scales adherent to the reflected periosteum, the disinfection of the exposed tissues with tincture of iodine, the packing of the cavity with iodoform gauze to be removed on the second or third day, and the provision of free dependent drainage.

This treatment should be instituted immediately on making the diagnosis. One must be careful to avoid the epiphyseal cartilages in doing the operation, since injury to this area results in a hindrance to further bone-growth from the injured end of the bone. When the infective process itself involves the epiphysis there is no other course to adopt, except that of thoroughly clearing away all diseased tissue, since if the surgeon be hindered by timidity, it is possible for the process to extend into the contiguous joint, when amputation may result. It is wise to mention the possibility of the subsequent shortening which one anticipates so that the

patient and his relatives may know what to expect.

Supplementing this operative treatment, the limb should be immobilized and local heat supplied, either as fomentation with hot boric acid and alcohol dressings or by using an incandescent lamp so arranged that its heat is directed on to the limb, or a combination of the two methods, the lamp tending to maintain the heat of the moist dressing. The patient should be freely purged and for this purpose, castor oil excels all other drugs. The patient should be given an abundance of good water to drink and often by giving water in the form of lemonade, aerated waters, mineral waters or weak tea, larger amounts may be drunk than if only plain water were offered. Large amounts of water provoke a diuresis and this, coupled with the purging, tends to increase the excretion of the toxins which the patient has absorbed from the diseased bone. With this treatment, the infection is rapidly overcome and no further extension of the process should occur.

The after-treatment consists in the removal of the gauze packing on the second or third day, or sooner if the temperature does not fall the day after operation. It is seldom necessary to insert rubber drainage-tubes, if the case has been diagnosed and operated on in the early hours of the disease. However, if the case has not reached the surgeon until the entire medullary cavity is filled with frank pus or even after the pus has begun to burrow in the soft parts, it is wise to remove the packing after 12 to 24 hours and to replace it by one or several drainage tubes, and this type of case will do very well when treated by Carrel's method, with frequent irrigations through many fine tubes each one leading down to the bone cavity. The wound should be kept open while it heals by granulation from the depths. It is occasionally possible to suture these wounds at their primary operation, leaving a corner of the wound open to permit removal of the gauze pack and for the insertion of a drainage tube if necessary. If doubt exists as to the wisdom of closing the wound at once, it should be left wide open and closed at a second operation after healthy granulation tissue appears. This should be postponed, however, until the wound has become free from infection which can be determined by examining the secretion microscopically. One must bear the fact in mind that the presence of bacteria is proof of infection, but that the absence of bacteria microscopically is not sufficient evidence to prove that a wound is sterile.

The cases which are not seen by the surgeon until actual necrosis of a section of the shaft or for that matter the entire shaft present greater difficulty. It is in these cases that immediate excision of the necrotic bone should never be practiced.

I have been impressed with the importance of this rule many times in cases in which it seemed impossible to have any portion of the shaft of a long bone restored to normal. In these cases we employed the treatment described above of splitting all of the soft tissues longitudinally down through the periosteum for a distance of 2 to 5 centimeters beyond each end of the area apparently infected and elevating the periosteum from its attachment to the bone for a distance of 1 centimeter each side of this incision and then applying hot, moist, boric acid and alcohol dressings and placing a therapeutic lamp over all. It has been surprising in many of these cases how small the total loss of bone has been ultimately. The bone which seemed hopelessly dead in many instances seemed to act in the capacity of a bone graft, being replaced to the greatest extent by new bone so that ultimately only a very small portion of the bone was lost.

In one case, a girl of 14, in whom the attack was unusually violent, an incision over the entire dorsal surface of the first metatarsal bone showed this structure black from end to end ready to be removed entirely. The treatment described above was employed and in 12 weeks the wound was completely healed without the loss of any portion of the bone. The entire bone served as a bone graft. The healing has been permanent. In my experience this observation has never been repeated to the same extent but a sufficient amount of bone has been saved in a large number of cases to convince me that much

value should be placed on this plan of treatment.

The important point to be gained comes from the fact that this treatment directs the lymph stream away from the substance of the bone so that there can be no advancement of the pathologic process, while on the other hand all of the natural forces can proceed with the work of restoration.

Whatever cannot be repaired by nature can be accomplished surgically later on at leisure when the patient has recovered from the acute condition and when the element of sepsis has been eliminated and the surgeon has to deal only with end-results of the disease.

CHRONIC OSTEOMYELITIS

The experience of the war has been of great value in furnishing experience in the treatment of chronic osteomyelitis although conditions are not exactly parallel. The important lesson universally learned corresponds with the experience of the few civilian surgeons who had a large experience with chronic osteomyelitis before the war, namely: (1) that in order to succeed one must remove absolutely all dead substance. In war surgery this means foreign substances in addition to sequestra which are alone to be considered in civil practice. (2) Provision must be made for filling the defect after all foreign bodies and dead bone has been removed and every portion of the remaining cavity has been thoroughly freed from infectious material.

Methods of closing the defect. My earliest experience with these cases was as an assistant of Moses Gunn in whose clinic we treated a great number of cases of chronic osteomyelitis.

After removing all sequestra and producing a smooth cavity he tried to obtain healing from the bottom by keeping the external wound open by means of a paraffin plug.

This plan proved very satisfactory although somewhat tedious. I also had an opportunity of observing many cases treated in the clinic of Charles T. Parkes who was my surgical chief following the death of Professor Gunn. The same plan of treatment and the good results continued.

For a number of years following this experience, I assisted Nicholas Senn in the treatment of many of these cases. After thoroughly removing all sequestra and infectious matter and smoothing the cavity in the bone, he chiseled away a sufficient portion of the involucrum to permit the edges of the wound to unite without the slightest tension.

Then the cavity was carefully disinfected with 5 per cent carbolic acid and thoroughly dried; then finely cut, decalcified bone chips, which had been preserved in 1:1000 corrosive sublimate solution, were dried and sprinkled with iodoform powder and carefully packed into the cavity in sufficient quantity to fill the cavity barely full. Then the edges of the wound were carefully sutured so that the coaptation was perfect. A very large dressing and immobilization splints completed the operation. The results were excellent. The reason why the method has not received more extensive adoption lies in the fact that few surgeons work with sufficient accuracy to carry out every detail of this procedure which is necessary in order to prevent the breaking down of the implanted graft. Moreover, the simpler method introduced by Max Schede about the same time brought identical results. Moorhof introduced a plug about the same time which we used with equally good results in a few cases but which we abandoned again because the results seemed no better than with Schede's method.

This method consists in the steps described in connection with Senn's method to the point of filling of the cavity, the technique then being as follows:

The cavity is left empty and the wound is closed by means of a double row of continuous catgut sutures the first row acting as tension sutures and the second row as coaptation sutures. An Esmarch constricting bandage is left undisturbed until the very large dressing supported with a number of splints has been applied and the patient has been returned to his bed with the limb elevated in order to prevent the cavity to fill moderately with a blood clot which may remain undisturbed because of the character of the dressing until it has become thoroughly organized.

In each of the three methods described last the element of absolutely preventing any disturbance of the clot filling the cavity in the bone is of the very greatest importance. The failure to appreciate this fact has resulted in most of the bad results following the use of these methods.

In cases in which there is not sufficient tissue to cover the cavity the method described by Emil Beck of carrying what skin is available toward the bottom of the cavity without tension has given very satisfactory results.

In a number of cases in which the healing has been too slow, we have covered the granulating surface with Thiersch grafts. It is amazing to see how these troughs will fill up after covering the granulations with Thiersch grafts. Occasionally we have loosened long lateral flaps and have united these in front over the defect in the bone and then we have covered the defects on each side by means of Thiersch grafts.

RECURRENCE

In our cases recurrence has seemed to be due most commonly to the fact that during the primary treatment the source of infection was overlooked so that the patient suffered from a re-infection rather than a recurrence in the usual sense of the word.

Many of these patients state that they had a cold or a sore throat or a toothache just before their osteomyelitis recurred. Upon making a careful examination one finds a buried tonsil containing an abscess or an abscess at the root of a tooth or some other focus of infection. For thirty years we have removed these infected tonsils and roots of teeth in many cases in which recurrence had occurred, and the patient has repeatedly remained free from trouble for a number of years.

Trauma is another common cause of recurrence. Apparently some slight injury determines the return of infection to a bone that has previously been the seat of osteomyelitis.

Sugar. Patients consuming large quantities of sugar are subject to the development of furuncles and carbuncles and occasionally this seems to be an element in determining the occurrence of recurrent osteomyelitis.

Cold and exposure. We have seen a number of recurrences following exposure to cold and wet. In these cases, however, there has been an infection of the tonsils, the sinuses or the air passages.

We have not been able to associate osteomyelitis with the occurrence of intestinal disturbances although *a priori* one would suppose that this might be a source of infection.

CONCLUSIONS

1. An early concise diagnosis and immediate surgical treatment is of the greatest importance.
2. The operation should invariably consist in splitting the periosteum for a distance of 2 to 5 centimeters beyond the area of pain upon pressure in the bone in each direction.
3. The periosteum should be loosened from the bone for a distance of 1 to 2 centimeters on each side of the incision.
4. In extremely severe cases this should be the extent of the primary operation.
5. In less severe cases ultimate healing can be hastened by carefully opening the medullary canal at the point previously located because of pain upon pressure.
6. Care should be employed to prevent traumatizing the tissues by rough chiseling.
7. Moist hot antiseptic dressings with fixation of the extremity and with the use of electric light treatment increases the comfort and facilitates healing.
8. The shaft of a long bone should never be removed until a good involucrum is formed.
9. In late cases or in secondary operations upon cases treated as above in the acute stage, every particle of dead tissue must be removed.
10. At this operation some definite plan must be carried out to facilitate closing the defect.
11. Skin grafting is of great value in many cases.
12. Local foci of infection such as abscesses of tonsils or teeth or sinuses, should invariably be eliminated at once upon undertaking the treatment of patients suffering from osteomyelitis.

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THE MOISTURE AND ASH OF MATERNAL AND FŒTAL BLOOD

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BY the comparison of maternal with fœtal blood in regard to their ash and water content, the following studies aimed primarily to assist in solving the problem of the placental interchange. The specimens were obtained almost simultaneously at the conclusion of the expulsive stage of labor, one from a vein in the arm of the mother, the other from the umbilical cord. As the work progressed, it became evident that more extensive data were desirable pertaining to the various months of gestation and especially to the periods immediately preceding and following labor. Also, whenever an opportunity presented, we made analyses in cases of eclampsia and allied intoxications.

The analytical method adopted was very simple. The blood was introduced into a volumetric flask of known weight containing a definite quantity of sodium oxalate. Thus at the proper time correction was made for the material used to prevent clotting. Both the total solids and the ash were estimated by the gravimetric method; the moisture, in other words, the quantity of water in the blood, was determined by the usual calculation. After removal of the corpuscles, the plasma was analyzed for moisture and ash.

Basing their opinion upon the presence of a normal number of red corpuscles, Ehrlich and later observers stated that hydræmia did not regularly accompany pregnancy. This evidence of an indirect character has been regarded as less reliable than that Nasse obtained in 1877 by chemical analysis, and textbooks at present ordinarily assume the existence of an hydræmia during pregnancy. From the first to the eighth month of gestation, Nasse found that the specific gravity of the blood decreased, while its water content increased; subsequently, there were changes in the opposite direction and normal values again prevailed at the time of labor.

The blood, according to Hammarsten, ordinarily contains from 77 to 82 per cent of water. In normal, non-pregnant women, we found values within these limits; and our results in four cases are given in Table I.

At different periods of normal pregnancy we made twenty-three analyses (Table II). The blood-moisture tends to rise during gestation; in several instances the values exceed that accepted by Hammarsten as the upper normal limit. Whether or not these should be considered as cases of hydræmia is problematical for a precise line of demarcation between normal and pathological percentages of water in the blood must be fixed more or less arbitrarily. Of more importance than the question of terminology is the fact that an appreciable increase in the water content of the blood does occur during pregnancy.

Comparison of the values obtaining at the various months of gestation with each other and also with those of normal women is graphically presented in Chart I. After the

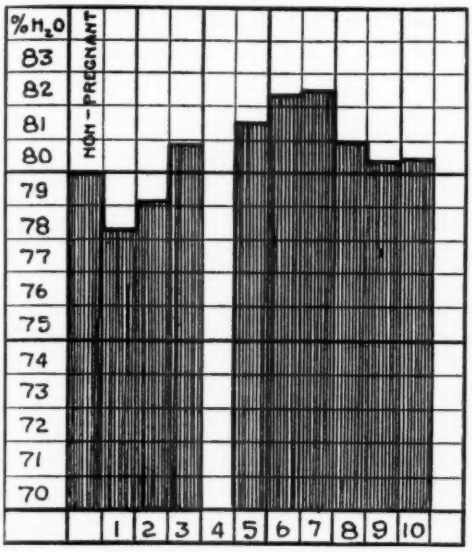

Chart 1. Moisture of whole blood. Vertical columns show month of pregnancy.

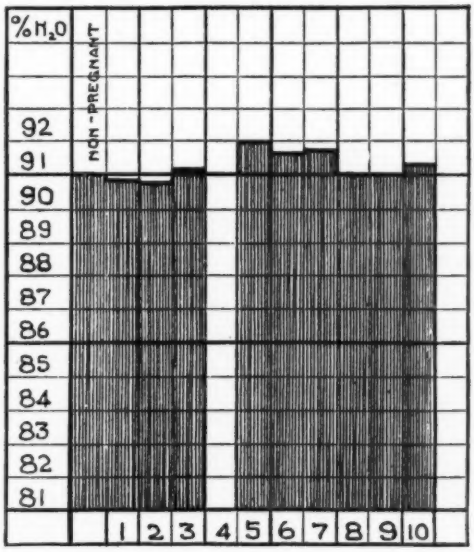

Chart 2. Moisture of plasma. Vertical columns show month of pregnancy.

first month which may be attended with a low blood-moisture, the water increases gradually until the seventh month and subsequently falls. At the onset of labor we find that the water content of the blood is again approximately normal, and labor itself apparently exerts no characteristic influence upon this blood constituent. With regard to the plasma also, the relative amounts of moisture and of ash at the conclusion of labor are found to be practically identical with the corresponding values in the initial stage (Table III).

The relative amount of water in the blood varies inversely with the number of corpuscles. Very important, therefore, for the interpretation of our results are the curves representing the number of erythrocytes and the specific gravity of the blood at the various months of pregnancy which Thompson constructed (Charts 3 and 4). His graphs are the reverse of our own for the blood-moisture (Chart 1), and thus teach that an increase in the water of the blood goes hand in hand with a decrease in the corpuscular count. The corpuscular decrease is not the prime factor in this phenomenon, for from moisture determinations on the plasma, we derive a curve (Chart 2) with smaller excursions but of the same type as that just described for the whole blood. Evidently, a relatively greater quantity of water in the blood harmonizes with the metabolic observations which demonstrate that the organism stores more water during pregnancy than at other times.

In view of the influence of the corpuscular count, the ash of the whole blood during pregnancy, as would be expected, varies from case to case. The plasma ash which is much less liable to individual variation remains normal throughout pregnancy.

The study of the placental interchange which was begun several years ago in this laboratory has recently been summed up by Slemons as far as the results pertain to the organic constituents of the blood. The evidence regarding amino acids and glucose indicates that these substances pass from mother to fœtus in accord with the laws of osmosis and the same explanation holds for the placental transmission of the fœtal excretory products. On the other hand, both biological and chemical data demonstrate that fats and lipoids do not pass the placenta at all.

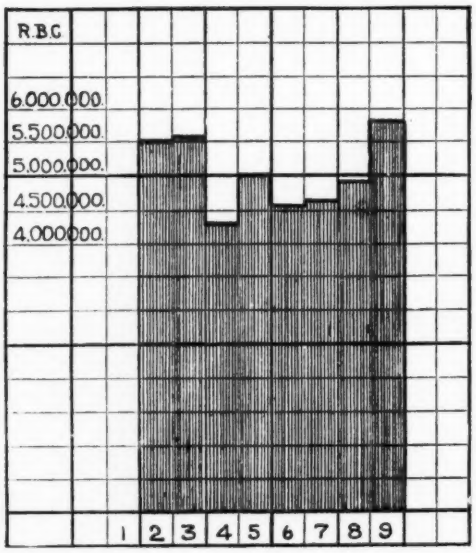

Chart 3. Red corpuscle count (Thompson). Vertical columns show month of pregnancy.

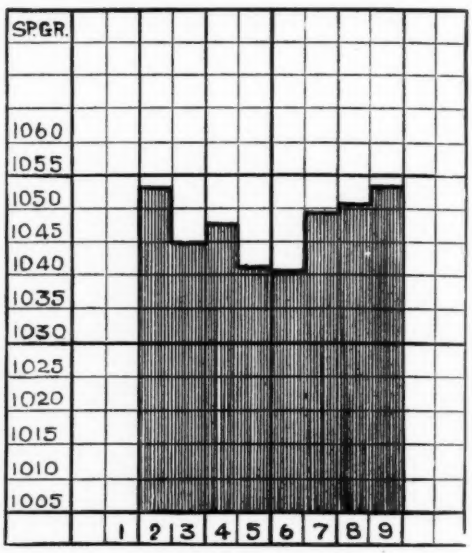

Chart 4. Specific gravity of whole blood (Thompson). Vertical columns show month of pregnancy.

The inorganic salts of the plasma (Table IV) we find generally to be in slightly higher concentration in the maternal circulation though occasionally the values for mother and fœtus are identical. An excess of ash in the fœtal plasma was found in a single instance, but there the fœtus was stillborn and an atypical analysis was not unexpected. The results in normal cases accord perfectly with the hypothesis that the inorganic salts required for fœtal growth pass the placenta by osmosis and this explanation, it would seem, may be confidently accepted except perhaps in the case of iron. From the study of stained microscopic sections of the placenta Hofbauer concluded that this organ actively participates in the transmission of hæmoglobin to the fœtus. At present we are not in a position to challenge his statement, but our results suggest the need for a special analytical study of the iron in the blood of mother and fœtus before Hofbauer's views may be adopted.

The data regarding moisture obtained for the purpose of studying the placental interchange are not to be interpreted so readily as might be supposed, and it may prove helpful to review certain accepted physiological facts before we discuss the analytical results recorded in the preceding table. The maternal organism, obviously, must provide the water required not only for fœtal growth but also for the amniotic fluid. On the other hand, fœtal waste products evidently are in solution as they pass through the placenta to enter the maternal circulation. Pertinent conditions, then, require that water may move readily from either of the two sides of the placenta to the opposite side.

The placental partition meets such requirements admirably, and it functions probably as a semipermeable membrane. This conclusion was announced by Kroenig and Fueth on the basis of their demonstration of a similar freezing point and consequently an isotonicity of maternal and fœtal plasma. The same conclusion was reached by Slemons, Sedgwick and Kingsbury, Campbell and Hunter, and Plass, who made a comparative study of various organic constituents of maternal and fœtal blood, and also by Cohnstein and Zuntz from their work upon the placental interchange of oxygen and carbon dioxide.

In the case of the whole blood, our analyses demonstrate the presence of relatively more

TABLE I.—NORMAL WOMEN

Name	Whole Blood		Plasma	
	Moisture—per cent	Ash—per cent	Moisture—per cent	Ash—per cent
Case A	78.9	0.8	90.7	0.7
Case B	79.8	0.8	91.1	1.2
Case C	80.0	0.7	91.0	0.7
Case D	80.4	0.8	91.0	0.9

TABLE II.—PREGNANT WOMEN

Case	Age	Para	Period of Pregnancy	Whole Blood		Plasma	
				Moisture —per cent	Ash —per cent	Moisture —per cent	Ash —per cent
1	22	III	1 mo.	78.3		90.9	
2	29	V	2 mo.	78.6		90.9	
3	31	VIII	2 mo.	79.8		90.8	
4	31	VIII	3 mo.	80.2	0.9	90.9	0.8
5	26	III	3 mo.	80.3		90.5	
6	37	V	3 mo.	82.3	0.55	91.8	0.9
7	22	II	5 mo.	80.7		91.0	
8	19	IV	5 mo.	82.5	0.75	92.2	0.9
9	26	V	6 mo.	83.8	0.5	91.3	0.6
10	29	X	6 mo.	82.4	0.9	92.2	0.7
11	23	I	6 mo.	81.0		91.3	
12	35	VIII	7 mo.	82.5	0.6	91.6	0.8
13	23	I	7 mo.	82.6	0.76	91.8	0.9
14	23	IV	8 mo.	79.0	0.65	90.8	0.8
15	23	I	8 mo.	81.8			
16	20	I	8 mo.	81.4		91.2	
17	27	III	8 mo.	81.1		91.5	
18	24	IV	8 mo.	82.4		91.9	
19	27	IV	8 mo.	80.8		91.3	
20	35	IV	8 mo.	80.8	0.7	90.6	0.97
21	43	IV	9 mo.	80.9	0.7	90.6	
22	27	IV	9 mo.	79.4	0.75	91.4	0.8
23	18	I	9 mo.	81.9		91.2	

TABLE III.—MATERNAL BLOOD DURING LABOR

Case	Age	Para	Onset				Conclusion				Remarks
			Whole Blood		Plasma		Whole Blood		Plasma		
			Moisture —per cent	Ash —per cent	Moisture —per cent	Ash —per cent	Moisture —per cent	Ash —per cent	Moisture —per cent	Ash —per cent	
24	24	I	78.6		91.3		80.6		91.3		Normal labor
25	30	III	82.1	0.75	91.8	0.7	79.7	0.8	91.0	0.8	Normal labor
26	27	I	82.6	0.8	91.8	0.8	83.4	0.9	91.7	0.95	Pre-eclamptic toxæmia. Blood pressure 150 mm. hg.
27	38	VIII	79.3	0.8	91.8	0.9	78.8	0.94	91.6	0.95	Pre-eclamptic toxæmia. Blood pressure 150 mm. hg.
28	27	I	81.5		91.4						Normal labor
29	21	I	80.7		91.3		80.2				Normal labor
30	33	V	79.7	1.0	91.5	1.1					Nephritic toxæmia without convulsions
31	28	III	79.3	0.7	91.1	1.0	80.3		91.3		Nephritic toxæmia without convulsions
32	37	III	83.6	0.8	92.2	0.9	83.7	0.8	92.2	0.7	Eclampsia. 8 months. Blood pressure 150 mm. hg. Albuminuria 0.2 per cent.
33	38	VI	81.9	1.0	92.0	1.2	81.5	0.9	92.0	0.8	Pre-eclamptic toxæmia. Blood pressure 180 mm. hg. Albuminuria, 0.5 per cent.

water in the maternal specimen. Among the normal cases, the average moisture for maternal blood was 80.5 per cent and for fœtal 76.8 per cent. If the fœtus was alive, the maternal moisture was always the greater; and this result clearly would be explained by the red cell count which according to Ballantyne is from a half to a million cells higher per cubic millimeter in fœtal blood. On the other hand, in the plasma the slight excess of moisture is in favor of the fœtus. Although the difference amounts approximately to only 1 per cent, it is a consistent difference applying equally to normal and complicated cases.

TABLE IV.—MOISTURE AND ASH OF MATERNAL AND FŒTAL BLOOD IN CASES OF NORMAL PREGNANCY

Case	Para	Whole Blood						Plasma				Remarks
		Hæmoglobin*		Moisture		Ash		Moisture		Ash		
		M. per cent	F. per cent	M. per cent	F. per cent	M. per cent	F. per cent	M. per cent	F. per cent	M. per cent	F. per cent	
34	I	52	85	81.3	76.7	0.65	0.8	91.9	92.2	0.6	0.6	Normal labor. Fœtal head soft.
35	II	71	93	80.2	79.2	0.8	0.95	91.0	92.9	0.9	0.8	Normal labor. Fœtal head moderately hard.
36	II	59	88	78.2	73.9							Normal labor. Fœtal head moderately hard.
37	II	59	87					91.2	92.7			Normal labor. Fœtal head moderately hard.
38	III	70	98	80.6	78.0	0.8	0.8	91.7	92.3	0.9	0.6	Normal labor. Fœtal head moderately hard.
39	V	78	105	79.0	75.9	0.9	0.75	90.6	92.1	0.9	0.7	Forceps. Ether anæsthesia. Fœtal head hard.
40	I	50	85	82.7	77.7	0.9	0.9	91.9	92.6	0.9	0.6	Forceps. Ether anæsthesia. Fœtal head soft.
41	I	64	97					91.6	93.0			Forceps. Chloroform anæsthesia. Fœtal head hard.
42	I	56	95	81.0	77.1	0.73	0.65	91.5	92.0	0.5	0.69	Forceps. Ether anæsthesia. Stillbirth. Fœtal head hard.

*Hæmoglobin estimations were made with the Dare instrument. The results serve to show the disproportion in the hæmoglobin of the bloods but the method does not yield absolutely accurate, quantitative determinations.

TABLE V.—MOISTURE AND ASH OF MATERNAL AND FŒTAL BLOOD IN CASES OF TOXÆMIA

PRE-ECLAMPTIC TOXÆMIA

Case	Para	Hæmoglobin		Whole Blood				Plasma				Remarks
				Moisture		Ash		Moisture		Ash		
		M. per cent	F. per cent	M. per cent	F. per cent	M. per cent	F. per cent	M. per cent	F. per cent	M. per cent	F. per cent	
43	I	67	95	81.3	78.8	0.8	1.2	91.0	92.9	0.55	0.5	Marked œdema. Albuminuria 0.2 per cent. Blood pressure 200 mm. hg.
44	I	78	109	77.9	70.7							Moderate œdema. Albuminuria 0.3 per cent. Blood pressure 195 mm. hg.
45	I			82.6 83.4		0.75 0.9		91.8 91.7		0.8 0.95		Onset of labor. Slight œdema. After delivery.
46	VIII			79.3 78.8		0.8 0.9		91.8 91.6		0.9 0.9		Onset of labor. Slight œdema. After delivery.
47	VI			81.9 81.5		1.0 0.0		92.0 92.0		1.2 0.8		24 hours antepartum. Moderate œdema. After delivery.

ECLAMPSIA

48	VIII	62	105	84.5	a78.4 b78.6	0.7	a0.7 b0.75	92.1	a93.4 b93.3	0.85	a0.8 b0.6	Marked œdema. Albuminuria 0.15 per cent. Blood pressure 182 mm. hg. Twins.
49	IV	55	96	80.0 80.7	78.2	0.75 0.8	0.9	91.7 92.2	93.6	0.9 1.2	0.6	3 hours antepartum. After delivery. Slight œdema.
50	II	69		81.2 82.5	78.5	0.97 1.01	1.21	92.8 93.1		1.2		9 hours antepartum. Moderate œdema. After delivery.
51	I	57		80.0 82.3				91.9 93.1				10 hours antepartum. After delivery. Marked œdema.
52	III			83.6 83.7		0.8 0.8		92.2 92.2			0.9 0.7	Onset of labor. Marked œdema. After delivery.

NEPHRITIC TOXÆMIA

53	VI	38		84.4		1.2						Marked œdema. Albuminuria 0.15 per cent. Blood pressure 228 mm. hg. No convulsion. Stillbirth.
54	II	82		77.0	81.9							Slight œdema. Albuminuria 0.2 per cent. Blood pressure 224 mm. hg. No convulsion. Stillbirth.
55	III	59	109	79.2 79.5	73.6			90.9 91.6	92.4			11 days antepartum. No convulsion. After delivery. Slight œdema.
56	V			79.7		1.0		91.5		1.1		Moderate œdema. No convulsion.
57	III			79.3 80.3		0.7		91.1 91.3		1.0		10 days antepartum. Slight œdema. After delivery. No convulsion.

On *a priori* grounds and likewise on the basis of previous analytical work relating to the comparative study of maternal and fœtal blood, we would expect an equal concentration of water in maternal and fœtal plasma, for, as we have said, excellent reasons exist for regarding the placental partition as a semipermeable membrane. It would seem, then, that some unrecognized physical or chemical factor takes part in balancing the osmotic pressures in the two circulations.

This factor may be sought in the unequal number of red corpuscles per unit volume of blood in the two organisms, for the corpuscles are not inert particles in suspension. The contents of each cell enclosed by a membrane must share in the adjustment of the osmotic pressure in the plasma. Moreover, we are not sufficiently familiar with the soluble, but non-diffusible substances of the plasma to know what rôle they play in its water concentration. Nucleon, the phosphocarnic acid which Sfameni isolated from fœtal blood in amounts of about 0.2 per cent, may belong in this category. In view of the possibility of such factors acting toward the reduction of the water concentration of the fœtal plasma and especially with so slight a difference between the mother and the fœtus, our results, it seems, support the view that water passes the placenta with equal readiness in either direction.

In cases of toxæmia, the ash and moisture determinations yielded variable results. During the pre eclamptic stage, that is before the onset of convulsions, the maternal values for whole blood and for plasma are within normal limits, but later in the presence of marked œdema the water content of both is increased. Venesection with subsequent administration of normal salt solution, usually causes a rise in moisture. An illustration of this phenomenon is afforded by Case 51 in which the determinations before and after the treatment in question yielded 80 and 82.3 per cent of moisture respectively.

From blood analysis it is impossible to distinguish between eclampsia and nephritic toxæmia which pathologists regard as distinct entities. Clinically, both are attended with albuminuria; but the former presents a characteristic liver lesion, the latter only a renal lesion. The tendency toward a higher blood moisture appears in eclampsia. However, the same phenomenon was noted in a case of nephritis, and as a rule the blood moisture varies directly with the degree of œdema.

Our observations of the ash in cases of toxæmia are not comprehensive enough for a final opinion. Such complications are infrequent and to gather abundant data requires a long period of time. However, it is our impression that the values for the plasma ash will generally be found high in patients who develop convulsions.

CONCLUSIONS

1. During pregnancy the water content of the blood is usually found to be between 77 and 82 per cent, the accepted normal limits. The tendency is toward the upper extreme, and in one-third of our cases this was slightly exceeded.

2. Examined month by month during pregnancy characteristic fluctuations in the blood moisture become apparent. It increases gradually until the seventh month and subsequently remains stationary or slowly decreases. At the onset of labor it is approximately the same as in the early weeks of gestation. The act of labor has no constant influence upon the blood moisture.

3. The water content of the blood and the corpuscular count vary inversely.

4. The plasma moisture, examined month by month, presents the same type of variation as that characteristic of the whole blood.

5. Quantitatively the blood ash and the plasma ash are found to remain normal during pregnancy.

6. Eclampsia may not be distinguished from nephritis on the basis of blood moisture. In either complication, the percentage of water may be great enough to constitute a true hydræmia, which is usually presented by cases with marked general œdema.

7. Identical values for the ash in maternal and fœtal plasma indicate that a free exchange of their inorganic constituents takes place through the placenta in accord with the laws of osmosis.

8. The moisture of whole blood is appreciably higher in the mother than in the fœtus.

9. The plasma moistures approach each other closely though by the method employed a difference of 1 per cent in favor of the fœtus is found constantly. Some unrecognized factor, physical or chemical, maintains osmotic equilibrium between the two circulations, and water passes the placental partition equally well in either direction.

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AMNIOTIC HERNIA[1]

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AMNIOTIC hernia so rarely occurs, once in about 6,000 cases, that brief discussion of the embryology and division or classification of the herniæ in the region of the umbilicus will not be out of place.

EMBRYOLOGY OF THE AMNION

The embryology of the amnion is important in that it helps us to understand the formation of the umbilical cord in which it plays an important rôle and occasionally of the umbilical region itself.

The amnion is formed early by a split in the epiblast of the germinal area, and according to Cullen consists of a small flaccid sac, covering only the posterior surface of the embryo. This fills with fluid and rapidly outgrows the yoke sac, so that in a short time it has entirely surrounded the embryo, which measures about 2.5 millimeters in length, except where the yoke sac and body stalk enter the ventral surface. The amnion continues to grow so that the yoke sac is pushed away from the embryo, and a resulting progressive constriction at the site of the yoke sac and body stalk forms the vitalline duct, which connects with the digestive tract, and there we have the formation of the umbilical cord. The amnion finally reflects itself on the cord to the umbilicus. About the tenth week the embryo is about 5 millimeters long and contains the differentiating gut in the cord; the gut begins to recede, which allows a perfect closure of the visceral plates, thus forming the umbilicus.

However, in rare instances, as we shall see, when the skin at the umbilicus is lacking, or fails to develop for some reason, the *amnion covers* the defect and it is known as an *amniotic umbilicus*, which allows the formation of *amniotic hernia*.

CLASSIFICATION OF UMBILICAL HERNIÆ

Umbilical herniæ may be classified as:

1. Congenital herniæ of cord,
2. Amniotic hernia,
3. Infantile umbilical hernia,
4. Adult umbilical hernia.

[1] Presented before the Chicago Society, February 6, 1920.

The term congenital hernia of the cord is truly a misnomer and really should be substituted by the term amniotic hernia, as I shall explain from my brief embryological review. This view is also endorsed by Moschcowitz, in his article entitled, "Pathogenesis of Umbilical Hernia," in which he states that a hernia into the umbilical cord is a congenital malformation and in no sense of the word a hernia; there is no valid reason, therefore, why this malformation should be included in a discussion of umbilical hernia, and he excludes it entirely from his discussion of the subject.

We recall that about the tenth week or so of fœtal life, as already stated, the gut occupies part of the umbilical cord which later recedes to allow a complete closure of the ventral plates, thus forming the umbilicus. But as this hernia forms, or potentially so before the formation of an umbilicus, the term amniotic hernia is correct, inasmuch as the umbilicus is defined as a depression of the skin, due to the formation of an underlying cicatrix which is left by throwing off the cord.

The coverings of this type of hernia consist of (1) the amnion, (2) layer of Wharton's jelly, (3) a thin sac which is continuous with the peritoneum, and sufficiently transparent in most cases to permit of the contents being seen. The layer of Wharton's jelly may not always be present. The size of the hernia may vary from a tiny protrusion to an almost complete evisceration. The latter two or true umbilical herniæ have for their coverings (1) skin, (2) fascia (rectus sheath), (3) peritoneum forming the sac, and are really a simple yielding of the umbilical scar due to incomplete closure of the mesoblastic layer in the infant; while the adult variety is commonly found in women and is associated with or without diastasis of the recti following several pregnancies. Space does not permit of a detailed description of the true umbilical herniæ as compared with our subject, but I simply want to make it clear that a true amniotic hernia is one which consists essentially of a reflected amnion with peritoneum which protrudes from an incomplete closure of the abdominal wall.

AMNIOTIC UMBILICUS

This term was first introduced by Nicaise in 1881, who said that according to Wiederhofer it is characterized by an absence of skin around the umbilicus, the defect being replaced by amnion which is reflected upon the abdomen from the cord. In such cases the surrounding wall is generally intact. The amniotic umbilicus does not usually interfere with the health of a child. In a case mentioned by Nicaise the amniotic disc was gradually closed, being replaced by scar tissue and the umbilicus completely closed.

Just what causes the defect which allows the formation of this so-called amniotic umbilicus is not exactly known. It may be due to an excess of amnion; to an infolding of the amnion along the cord and skin; to a delayed recession of the gut into the abdomen; to an excessively large cord or lack of skin. However, one of the first explanations is that given by Runge in 1893, who in the course of a discussion of the subject, said that in rare instances there is a preponderance of amnion and a lack of skin at the umbilicus, and spoke of the condition as an amniotic umbilicus. Under these conditions with simply the amnion covering up the defect in the skin, the intra-abdominal pressure naturally forces out this thin membrane and forms a hernial protrusion. The size, of course, will vary depending on the amount of abdominal skin lacking over this area, the underlying muscular walls, and the increased abdominal pressure.

Cullen cites Stewart, who, in 1905, reported a case of hernia of the cord, the size of a very large apple, in a well-developed male child. The cord dropped off at the usual time leaving the sac exposed. The child did well and as the parents were anxious that something be done, a plastic was performed disregarding the advice of Stewart. The sac contained a portion of the intestine and the whole of the liver which was so adherent to the sac that separation was impossible.

In 1903, Dr. S. E. Sanderson, of Detroit, saw a similar case in which the defect in the abdominal wall was covered by a thin transparent membrane through which the entire abdominal contents were clearly visible, while the partly developed abdominal wall, composed

of skin, muscle, and peritoneum, was retracted. The child was 1 day old when seen by the Doctor, but seemed to be unaffected by the physical defect. But the thin abdominal covering began to dry and with the increased intra-abdominal pressure produced a marked hernia. Dr. Sanderson felt that the time for repairing this defect was past, but as a last resort advised operation. After resecting half of the liver, the muscles and skin were brought together. The child withstood the operation fairly well but finally died.

In 1913, H. Wellington Yates, of Detroit, reported a case of an 8 months old child weighing about 6 pounds and 18.5 inches in length which had a large hernial protrusion measuring 14 centimeters broad and 17 centimeters long. The child was otherwise normal. No autopsy was obtainable, but according to Yates, the walls of the hernial protrusion were almost transparent. The protrusion consisted of amnion and peritoneum at the base of the skin, and was continued for a short distance upon the sac, the larger part of the intestine being in the sac. He also cites several other cases from the literature in his reprint.

Bonney, in 1914, in the *Proceedings of the Royal Society of Medicine* presented a specimen which consisted of the umbilical cord on which about 1 inch from the umbilicus was situated a cystic swelling rather larger than a cricket ball. The cyst contained the major portion of the child's intestine attached to its inner surface by a short mesentery, and it communicated with the peritoneal cavity by a narrow neck traversing the short length of the cord that intervened between the cyst and the umbilicus. The practitioner attending the labor had ligated and divided the cord between the cyst and the umbilicus, not realizing that the cyst contained the intestine. Bonney saw the case 24 hours later and attempted operation to save the child's life. Postmortem examination showed that nearly all of the intestine had been removed with the hernial sac. The specimen was shown for its clinical interest. He said that almost every hernia into the cord projects directly from the umbilicus, and the intestine in it can be seen through the wall formed of the thinned-out cord. In the much rarer form now recorded a short length of the normal cord intervened between the sac and the umbilicus.

The literature on the whole was very brief on the subject; in fact Williams fails to mention it entirely and De Lee says: "Herniæ into the cord are not so very rare. This must always be thought of while tying the cord and if operable should be closed immediately to avoid peritonitis."

On November 30, 1919, I was asked by Dr. Irving Stein, associate in the obstetrical department of Michael Reese Hospital (service of Dr. Frankenthal), to see a baby born the day before at 2:30 p.m., which presented a large ventral hernia, the size of the child's head, together with undescended testes. The history of the mother is as follows:

Mrs. E. K., age 24; nationality, Jewish; occupation, housewife; residence, 812 Paulina Street; date of admission, November 29, 1919, at 11:45 a.m.; II-gravida; diseases, none. Menstruation began at age of 15, 4 days' duration, moderate amount, no pains. The first pregnancy resulted in miscarriage at three months; previous labors and childbirths were normal. Father is living and well; the mother is dead. The husband is well. One child, two and a half years old, is living and well.

The child, which weighed about 6 pounds, was apparently well with the exception of undescended testes and a large hernial mass which occupied the entire abdomen projecting from the same. The mass was covered with peritoneum and amnion. The amnion seemed to be reflected on to the mass and contained a considerable amount of a straw-colored fluid (Wharton's jelly). Through the thin, transparent walls of these coverings could plainly be seen stomach, liver, and intestines. The child died on the second day and the postmortem findings were as follows:

External examination. The autopsy was done 8 hours after death. The body was that of a white male infant 47 centimeters long. The skin is cyanotic. The preputial opening is small and the prepuce can not be retracted. Arising from the anterior abdominal wall is a hernial sac which measures 10.5 centimeters in the longitudinal axis, 10 centimeters in the transverse axis, and 7.5 centimeters in the anteroposterior diameter. The normal skin of the abdomen extends up on to the wall of the sac for a distance of 1 to 2 centimeters from the margin of the latter. The rest of the surface is covered by thin, glistening, membranous tissue, which has a yellowish color. Intestinal coils can be felt through the wall of the sac. The hernia extends from the ensiform region to a slight distance below the umbilicus. The stump of the umbilical cord is given off from the lower portion of the sac, at a distance of 2 centimeters from the lower margin of the latter. In an area 6

Fig. 1. Roentgenogram of author's case.

Fig. 2. Photograph of author's case.

centimeters in diameter above the cord, the wall of the sac is separated into two layers by a collection of fluid. The fluid cannot be made to pass beyond the margins of the bleb-like area by pressure. The thorax is long and narrow.

Internal examination. A medium longitudinal incision is carried downward so as to pass to the left of the attachment of the hernia. The peritoneal cavity contains a small amount of blood-tinted fluid in which are fibrinous masses. The pleural and pericardial cavities are normal.

The thymus is small and extends to the superior border of the heart.

Heart. The right auricle and the cavæ are greatly distended. The vessels are given off from the heart normally.

Lungs. Both are crepitant and pale. The fissure between the upper and lower lobes of the left lung, and that between the upper and middle lobes of the right lung are not complete.

Abdominal cavity. When the anterior abdominal wall and the hernial sac are dissected away, the latter is found to contain the pyloric half of the stomach together with most of the intestinal tract, and also the greater part of the liver. The spleen is pulled by its attachment to the fundus of the stomach so that it lies in the mid-line. The coils of intestine in the hernia are attached to each other and to the inner surface of the sac by a small amount of easily broken, yellowish, plastic exudate. From the lower portion of the anterior surface of the right lobe of the liver a short, vascularized, fibrous band 2 millimeters in diameter runs to the inner surface of the sac. The upper portion of the right lobe of the liver is broadly and closely attached to the inner surface of the sac by a thin layer of fibrous tissue, which is apparently the dislocated reflection of the peritoneum over the dome of the right lobe. The diaphragm is drawn downward in the mid-line anteriorly, and apparently the lengthening and narrowing of the thorax has been caused by the same traction. The bladder is elongated and its fundus is drawn upward out of the pelvis by the traction of the urachus, which runs to the umbilicus included in the lower portion of the hernial sac. The umbilical vein runs along the inner surface of the anterior wall of the hernial sac from the liver to the umbilicus. The left kidney and adrenal lie high up in the left diaphragmatic vault and the long axis runs downward and outward from the mid-line. The right kidney and adrenal occupy a similar position on the right side. The renal vessels and the ureters take a normal course. On the left side there is a strong anastomosis between the adrenal and the renal veins. The gastro-intestinal tract, pancreas, liver, and spleen bear normal relationships to each other, but all are dislocated anteriorly and to the right by the hernia. It is impossible to replace the organs in the abdominal cavity. When the organs are removed the abdominal cavity is found to be short and small, due in part to lengthening of the thorax by traction and in part to failure of the abdominal cavity to develop because of the hernia. The testes, which are normal, lie in the abdominal cavity at the level of the iliac crests. The umbilicus, which runs over the lower portion of the hernial sac for a short distance, is not otherwise involved in the hernia. The well-developed rectus muscles are separated by the contents of the hernia.

The spleen measures 4 by 2.2 by 1 centimeter. It is dark red in color and firm. There is a deep median notch.

The liver measures 8 by 6 by 3.5 centimeters. The left lobe is small. The tissue is dark red in color and is rather soft in consistency. The gall-bladder and ducts are normal.

Kidneys. Each measures 3.5 by 2.5 by 2 centimeters. They appear normal on section.

Microscopic examination. Lung. The tissue is incompletely expanded by air.

Spleen. Malpighian bodies are small and numerous. The pulp is moderately congested.

Liver. The liver cells are swollen and granular. Veins and capillaries are distended with blood. In a rather broad zone beneath the capsule the congestion is extreme and has led to atrophy of the intervening cords of liver cells through pressure.

Kidney. The tubular epithelium is swollen and cloudy.

Adrenal. The cortex is thick and contains much lipoid material.

Intestine The peritoneal surface is covered by fibrinopurulent exudate and the vessels of the wall are greatly distended by blood.

Hernial sac. In sections which include the junction of the abdominal skin with the thin portion of the wall of the sac, the skin is covered by normal epidermis. The underlying stroma is œdematous. As the thin portion of the wall is approached, the epidermis becomes thinner, although still present and still covered by a horny layer, but papillæ are absent. The portion of the wall covered by thin epidermis goes over into the membranous portion of the sac, the epidermis disappearing and being replaced by a superficial thin zone of necrosis in which tissue elements are not recognizable. On the surface a thin horny layer can still be distinguished for a short distance beyond the thin epidermis. The tissue of the thin portion of the wall is markedly infiltrated by polynuclear leucocytes, many of which are fragmented. The connective-tissue bundles between the areas of infiltration are œdematous and have lost most of their nuclei. On the inner surface of the sac, peritoneal membrane is not recognizable, although there are a few areas covered by a thin layer of degenerated cells which are suggestive of peritoneal endothelium. In a section which includes the cord and part of the sac wall, the cord is flattened and somewhat ovoid in shape. It contains two large blood-vessels, an artery, and a vein. The cord and a thin layer of sac tissue to which the former is attached are separated from the rest of the wall by a cleft-like space, which is part of the lower margin of the fluid-filled, bleb-like area present in this region and noted in the gross. In this space are several hyaline, granular, eosin-stained, round, oval and elongated bodies whose nature can not be definitely ascertained. They contain a few shrunken, elongated nuclei. Their size and shape corresponds to that of degenerated chorionic villi, although nothing is recognizable which permits the conclusion that they are villi. About half of the free surface of the cord is covered by a thin layer of epithelium. This disappears at each side before the area of attachment to the sac wall is reached. The tissue of the cord appears degenerated, and that of the sac wall beneath the cord shows the same polynuclear infiltration present elsewhere in the wall. In a section from another portion of the margin of the bleb-like area of the sac wall, the conditions are as follows: In a great part of the free surface the stroma is exposed. In a still greater portion the surface is covered by a thin layer of granular, structureless material which takes a deep nuclear stain. In several areas the surface is covered by a single layered, very regular cuboidal epithelium, the nuclei of whose cells are small and condensed. In one place the cells of the covering epithelium are more flattened, their cytoplasm is hyaline, and their nuclei are elongated and pyknotic. Beneath the epithelium the superficial covering layer of the bleb-like area is formed of œdematous and degenerated connective tissue, throughout which polynuclear leucocytes are scattered in considerable numbers. The lower surface of the covering layer is free of epithelium in most of its extent, but here and there are small areas covered by a single layer of cells which are of about the same height as those on the free surface, but which are considerably broader. Their nuclei are large, oval, and vesicular. Some of these cells are considerably swollen; then their shape and arrangement are more irregular. Where this layer of cells is absent the tissue is closely infiltrated by polynuclear leucocytes. Next comes the space, which in life was filled with fluid. The lower wall of the space is formed by a layer of œdematous connective tissue like that of the upper wall, but about twice as thick. Next the space this is covered by a single layer of broad cuboidal cells like those present on the under surface of the upper layer, but this cell layer is more complete than in the latter situation. At the margin of the space, where the two layers bounding the space fuse, cells of the same type can be followed for some distance into the single layered wall of the sac, lying beside each other in groups of two to four. The lower wall of the space is more densely infiltrated by leucocytes than the upper wall. Upon the under surface of the lower wall, i.e., the inner surface of the hernial sac, there are a few groups of flattened cells which have oval or elongated nuclei. These cells are arranged in a single layer. Loosely attached to the greater part of the surface is a layer of tissue which is thin but which varies in thickness. It contains many of the flattened cells which in places cover the inner surface of the sac. In addition there are also young, spindle, connective-tissue cells, together with lymphocytes and leucocytes. In one place this layer contains many fluid-filled spaces of varying size and shape, apparently dilated lymph spaces. This layer of cellular tissue attached to the inner wall of the sac is apparently proliferated peritoneal membrane.

DISCUSSION

The point of greatest interest in this case centers in the possible relationship of the amnion to the hernia. If we accept, as we must, the belief that the amnion ceases normally at the placental insertion of the cord, it is necessary first of all to establish that amniotic tissue is present in the hernia, since any attachment of the amnion to the body surface of the fœtus is an abnormality. That any amniotic tissue is present in the hernial sac is difficult of absolute proof through the microscopic examinations made because of the degenerative and inflammatory changes which are present. That the body epidermis is not continued over the surface of the sac is evident from both the gross and the microscopic examination. Except at the periphery, where the skin is continued up on to the sac for a short distance, the wall of the sac is composed of connective tissue incompletely lined internally by acutely inflamed peritoneum and by proliferating peritoneal membrane. Such epithelium as is still recognizable, more especially in the region of the bleb-like area which was present above the umbilicus, is of the single layered cuboidal type and has the appearance of amniotic epithelium rather than of body surface epithelium. The cleft-like space is lined by similar

epithelium. If this is amniotic epithelium, it becomes difficult to understand how both the space and the free surface could be covered with such epithelium. The only explanation which would appear to answer the conditions found, would be adhesion between amnion and anterior abdominal wall in the region of the hernia, with folding and duplication of the amnion in that portion of the hernial sac which contained the fluid filled space. The case apparently belongs to the common type of congenital abdominal hernia in which amniotic adhesion is considered the etiological factor.

TREATMENT

From the cases recorded it is obvious that operation immediately after birth is imperative in order to save the child's life.

Sanderson states, that the time to operate is immediately after birth before there is any drying out of the thin membrane covering the abdominal wall, and before the hernial protrusion has been increased in size by accumulation of fluid in the stomach. The only cases which are amenable to treatment by operation are those which are small enough so that their contents can be reduced into the abdomen and a closure of the abdomen effected. When resection of liver or other abdominal contents is required the child usually dies.

Olshausen method. This technique has been effective in small protrusions of this type. The method consists in separation of the skin around the sac, removal of Wharton's jelly, and reduction of the hernia *en masse* without opening the sac and suture of the skin.

Palliative. Small protrusions can be treated by carefully cleansing the parts, keeping them as nearly aseptic as possible and applying pressure to the hernial tumor by means of adhesive plaster, and encircling the entire abdomen.

SUMMARY

Amniotic hernia is a rare condition.

Congenital umbilical hernia of the cord is a misnomer and should be substituted by the term amniotic hernia.

The treatment, when resection of abdominal organs is not indicated is operative immediately after birth; for small protrusions or in case of failure to recognize the condition until late, is palliative.

I am deeply indebted to Dr. O. T. Schultz, director of the Pathologic Research Institute of the Michael Reese Hospital for the above postmortem and pathologic report of this case.

DEPARTMENT OF TECHNIQUE

THE MANAGEMENT OF FRACTURES OF THE FEMUR[1]

By JOHN J. MOORHEAD, M.D., F.A.C.S., New York City
Professor of Surgery, New York Post Graduate Medical School and Hospital; Visiting Surgeon, Harlem and the Park Hospital

BY common consent war fractures of the femur were the most difficult to manage, the most likely to cause fatalities, the most productive of deformity. In the early years of the war, Sir Robert Jones was authority for the statement that the death rate in this group was 80 per cent; this appalling loss happily was reduced to 20 per cent in the later years of the fighting. The grossly compound comminuted infected types of fracture of military service are very rarely encountered in ordinary practice, and for that reason alone many of the appliances of great service in the war are not needed in peace time. The great essential in the treatment of war fractures was a splint that could be used with safety, ease, and comfort during transport, a splint likewise that would permit access to the wound during subsequent treatment. An appliance of this sort is provided by the Thomas splint, the employment of which became routine in the British, French, and our own army and unquestionably did much to lower mortality.

The treatment of fractures of the largest bone in the body imposes upon the surgeon in civil life the largest responsibility, demands the maximum of initial and subsequent care; indeed, fracture of the femur is the high mark in major surgery in the field of fractures, a field in which deformity and disability are supposed to be inevitable.

Practically speaking we can classify fractures of the femur as they occur at the articular ends and in the shaft, thus giving us three zones of incidence.

The first, or upper third zone, may be said to consist of: (1) fractures of the head or neck—capital and cervical cleavage; (2) fractures near the trochanters—juxtatrochanteric cleavage.

The second or middle third zone consists of all fractures of the shaft between zones 1 and 3.

The third or lower zone consists of (1) fractures above the condyles—supracondylar cleavage; (2) fractures of the condyles—condylar cleavage.

The epiphyseal groups are in the upper and lower zones and correspond respectively to the cervical and supracondylar varieties.

Irrespective of this zonal distribution there are certain important, almost fundamental considerations determining our procedure. The first of these principles is the recognition that a fracture is a lacerated wound of bone and periosteum and that there are always associated lesions of contiguous joints in the form of synovitis, arthritis and tenosynovitis, together with lesions of the overlying muscles, and of the vascular and neural vessels. Our problem then is not merely directed to the primary bone lesion, but is quite as much directed to this associated important pathology. We recognize also that the deformation following bony cleavage is due to disturbance of muscular compensation and that we "set" the bone only by "setting" the muscles which no longer maintain their accustomed status as to origin and insertion.

We recognize also that there are two groups of fractures and either may be simple or compound.

Group I comprise those in which there is displacement of fragments, the displaced or malaligned group.

Group II comprise those in which there is little or no displacement of fragments, the non-displaced or aligned group.

In Group I we have the immediate problem of reduction and retention; in Group II our immediate problem is one of retention only.

We recognize also that early reduction means easier and more accurate reduction, and with this in view, preliminary traction is a great aid irrespective of the treatment imposed later.

We recognize that a lacerated bone like any other laceration heals by primary union when the edges are well coapted, thus leading to a minimum of callus; but that non-coaptation means secondary union and maximum of callus.

We recognize that we can convert a compound into a simple fracture by mechanical sterilization

[1]Read at the Surgical Section, New York Academy of Medicine, February 6, 1920.

that aims to expose the fracture site to vision by the exsection of all bruised or otherwise damaged tissue. This *débridement* and primary suture we reserve for selected cases; we do not practice it in badly comminuted cases nor when the injury is more than 24 hours old. The safest procedure in converting any compound into a simple fracture is to resort to primo-secondary or delayed primary suture in which all the steps except suture are taken, and the actual suturing is performed between the third and sixth day, when we are assured clinically and bacteriologically of the asepsis of our wound. An already infected fracture is a problem in osteomyelitis, and the method of progressive chemical sterilization must be our treatment.

We recognize that non-union usually means mal-union brought about by faulty reduction or faulty retention (too loose or too tight splintage). The next commonest source of non-union is interposition of soft or hard parts, in effect a spontaneous arthroplasty. We do not believe syphilis to be a common cause of non-union, but do believe that cardiovascular disease is a considerable factor. Likewise focal infection, especially of the teeth, is an element in this process; we have also had non-union in those who never ate meat or never ate vegetables. As to frequency, non-union of the femur is fourth on the list beginning with the tibia, forearm, humerus. We rarely see non-union in the fibula despite the marked overriding so often found in this fracture. This is probably due to the very large nutrient canal. Non-union in any joint-fracture except the neck of the femur is exceedingly rare.

We recognize that the introduction of non-absorbable material to act as an internal splint is occasionally necessary, but this should be the last resort even in selected cases. The operator should possess unusual mechanical skill and be prepared to exercise an ultraaseptic technique in which all hand contact with the wound is prevented. Infection after plating or wiring is a regrettable occurrence in the leg or arm; in the thigh it has often been a tragedy. The tolerance of the tissues to this form of foreign body has frequently been evidenced, but the majority of surgeons now remove the plate or wire after it has served its purpose.

We recognize the danger of applying encircling plaster-of-Paris casts or other splintage combining the demerits of pressure, hiding of the part, and rendering joint motion and massage impossible. For these reasons, fracture of the neck of the femur is the only displaced variety of fracture subjected to this type of encasement.

Fig. 1. Plaster spica for fracture of femur. Note extent of abduction.

These are some of the essential principles; they are the foundations on which our treatment is based. We will never obtain standardization or uniformity of results until we agree upon the precepts and practices in fracture surgery after the manner of agreement in other branches of surgery.

For purposes of reduction we have resort to either non-operative or operative methods.

Non-operative or external reductive methods consist of—

1. Manual reduction which is completed in one stage;

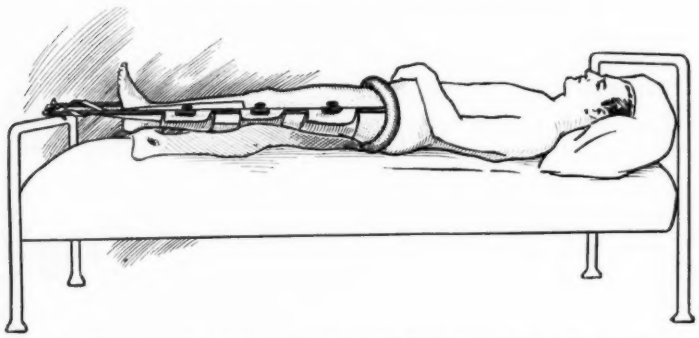

Fig. 2. Thomas splint in fracture of the thigh or leg. Note adhesive traction straps fastened to lower end.

2. Traction and suspension methods in which there are applied to the limb straps to which weights are attached so that alignment is gradually attained;

3. Traction in the Thomas splint;

4. Mechanical traction methods as by the very efficient Hawley table.

Operative or internal reductive methods consist of—

1. Skeletal traction by which traction is obtained by transfixing the bone (the Codivilla-Steinmann method); or by tongs or calipers attached to the outside of the bone (the Ransohoff method); or by passing a metal band over the bone (the Finochietto method);

2. Internal adjustment by direct exposure and alignment of the fragments with or without fixation by absorbable material such as kangaroo tendon or bone; or non-absorbable material such as wire, nails, screws, clamps, bands or plates.

The choice of the method of treatment depends upon (1) the physique of the patient; (2) the site, extent, and duration of the fracture; (3) the surroundings of the patient (home or hospital); (4) the experience of the surgeon.

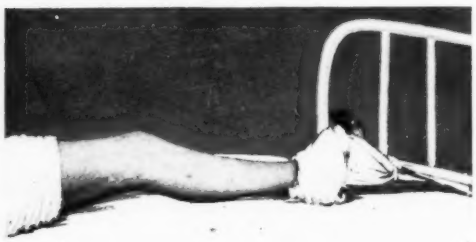

Fig. 3. Traction by sheet around ankle.

In the aged, the infirm or diseased, our treatment will be directed more to the general than to the local condition and we will not impose any added burden by our apparatus or forced restraint. Recently in a fracture of the neck of the femur in a diabetic, a fatality was doubtless hastened because I administered an anæsthetic for the application of a plaster spica. We must not forget that true fracture of the neck of the femur may occur at any age and that it is an incident of decades more than decadence.

The second factor, relating to the fracture itself, is very strongly linked to the remaining factors as to the place in which the patient is to be treated and the surgeon's own experience. It is, of course, advisable that fractures of the main bones should be regarded as a hospital problem; but we must realize that a great many patients for a variety of reasons demand home treatment, and this is especially true in fracture of the neck of the femur. Further than this, at present the interne and nursing staff in very few hospitals are sufficiently trained to undertake the supervision of any case in which the apparatus is not of a fixed type. For this reason, even in a well-equipped hospital, the treatment of this class of case by traction and suspension, or even by calipers, will be limited until a definite group of the attending staff, and their assistants intensively focus on this important phase of traumatic surgery.

For all cases in Group II, the non-displaced or the aligned group, our method of choice is a plaster-of-Paris spica for the neck of the femur variety and molded plaster-of-Paris anteroposterior splints for all the others.

For the cases in Group I, the displaced or malaligned group, the method of choice is immediate preliminary traction in a Thomas splint or adhesive plaster straps with weights until per-

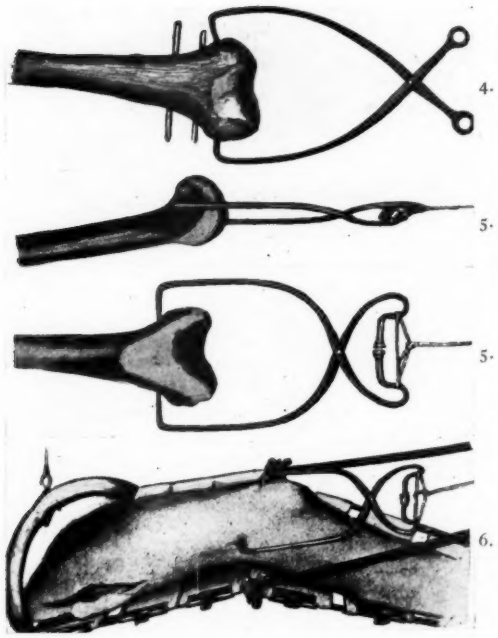

Fig. 4. Calipers (U. S. Army type) applied to condyles. Transfixion pins as used in the condylar or supracondylar areas.

Fig. 5. Calipers applied—anteroposterior and lateral views (after Pearson).

Fig. 6. Calipers inserted and Thomas hinged splint applied (after Pearson).

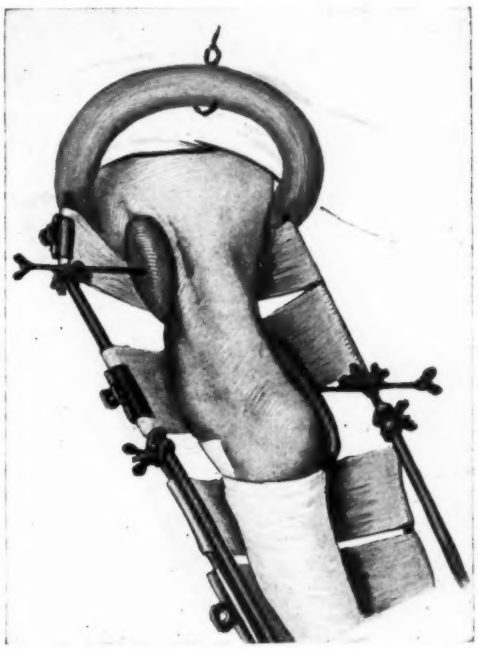

Fig. 7. Thomas splint showing use of pressure pads to correct angular deformity (after Pearson).

manent reduction can be made under anæsthesia with or without a traction table, at which time a split plaster-of-Paris spica is applied. The earlier the reduction, the easier and more satisfactory. However, experience has taught that in some cases, the primary attempt at reduction is wholly unsatisfactory or is incomplete; hence our rule is to make two attempts before resorting to skeletal traction or open operation.

There are certain fractures in which no external method of correction has given me satisfactory results and for want of a better name, these are called "the irreducibles" and in these skeletal traction has become the sole resort. This group consists of all supracondyloid forms with typical backward displacement of the lower fragment; all subtrochanteric forms with much displacement; all of the shaft in very muscular individuals in which there is overlapping of over an inch; and in any form (except the neck) in which more than a week has elapsed without correction. The need for skeletal traction is the greater in compound forms and in those in which the cleavage is almost transverse or of the smooth oblique type as in these slipping after reduction may occur. Comminuted, serrated, or spiked forms are as a rule rather readily reduced and are much more likely to result in solid union than those of the opposite types.

To repeat then, all the reducible varieties are treated either in a plaster spica or molded plaster strips; the irreducibles are treated by skeletal traction, preferably by the transfixion method. The use of the Buck's extension and allied apparatus has been practically completely superseded by other forms of external traction in which the Thomas, Hodgen, or Blake-Keller splint is used. Apparatus of this type is very efficient in the majority of cases when properly applied and watched but has the disadvantage of requiring constant supervision and frequent adjustment, and it is not by any means a method of choice for the occasional user. For very greatly overlapped, for long standing, and for most of the supracondyloid group, I do not believe any method wholly satisfactory unless traction is applied to the skeleton

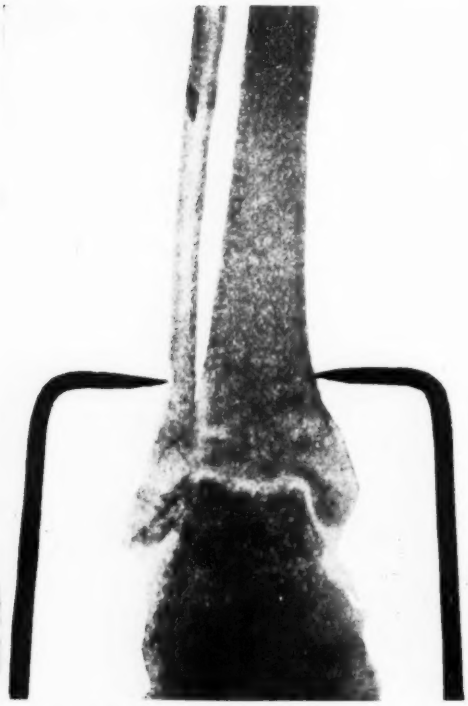

Fig. 8. Calipers applied for fracture of the leg (after Pearson).

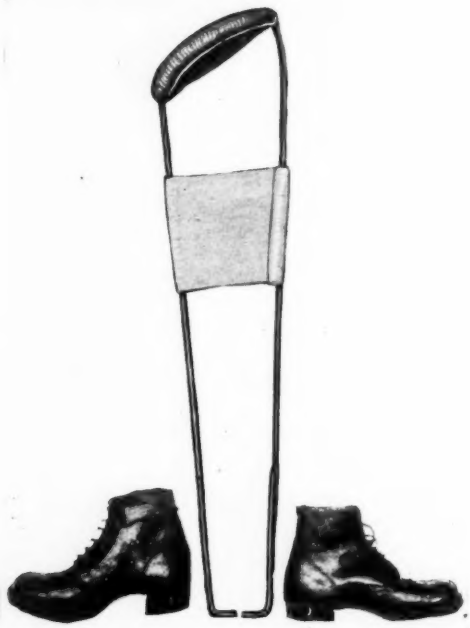

Fig. 9. Walking calipers made of Thomas splint, the lower end of which is cut to be inserted into heel of a heavy shoe, as indicated (after Pearson).

itself, and for this purpose there is the choice as between open operative correction, or by resorting to transfixion, the calipers, or the stirrup.

The calipers or tongs have the disadvantage of slipping, even though penetrating the thickness of the cortex of the bone; this probability is the greater if penetration is just into the margin of the cortex, as so strongly advocated and employed by Pearson in his admirable war service at Edmonton, England. A further difficulty is that one or both sides of the calipers will extrude if the weights are released for an instant—and this is an occurrence to which we are all liable in the management of the average case. In military hospitals we had the advantage of a staff trained in fracture work by intensive experience; we had wards fitted especially for the care of that class of case; and best of all we had patients who cooperated and willingly obeyed orders. Incidentally the problem of the management of an extensively excised and much compounded fracture of the femur is a very different problem from the management of the ordinary simple fracture. The former is easy to reduce because of lessened muscle pull, but hard to retain for the same reason; the latter is harder to reduce but easier to retain.

Because of these named difficulties incident to traction by straps or the tongs, preference is given to transfixion in that irreducible group in which operation is the alternative. Open correction is never done unless as a part of the conversion of a compound into a simple fracture. Direct exposure and correction of a fractured femur in a muscular subject is an operation of considerable gravity; if plating or wiring is added, the procedure is hazardous, especially if the surgeon is unfamiliar with an ultraaseptic technique in which all hand contact is prohibited.

Transfixion or nail extension was first used by Codivilla of Bologna who passed a pin or nail through the os calcis in the treatment of fractures of the thigh and leg. Steinmann, of Berne, modified the procedure by penetrating the region of the condyles of the femur, and the method is commonly known as the nail extension method or the Codivilla-Steinmann nail method.

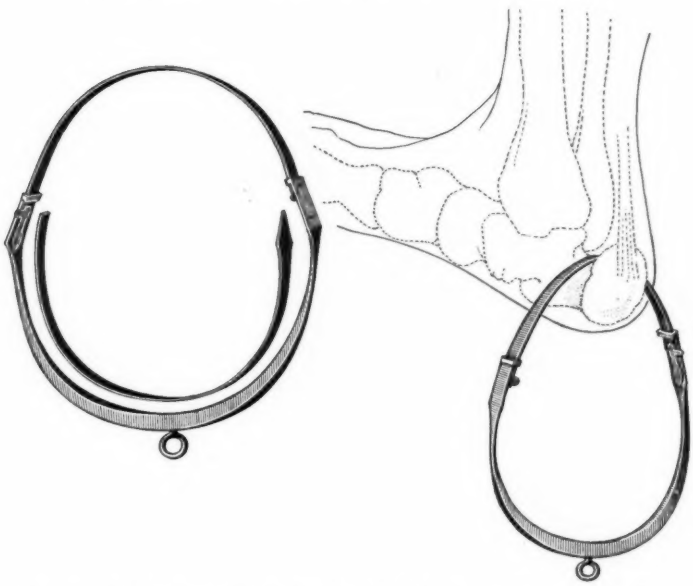

Fig. 10. Finochietto stirrup and method of obtaining traction by passing it over the os calcis.

METHOD OF INTRODUCTION

Local anæsthesia is said to suffice, but general narcosis is better. The knee is flexed to about 165° on a sandbag, and the region of the lower thigh to below the knee is shaved and iodinized. If the fracture is of the low supracondylar type, the condyles are to be transfixed, otherwise the flaring part above them (supracondyloid ridge) may be chosen. If the condyles are involved, or if there is a wound in their proximity, transfixion can be made through the tibia just below the level of the tubercle. The internal condyle and the adductor tubercle just above it are readily identified and serve as landmarks.

Having located the internal condyle, the external condyle can be located by spanning the limb with the thumb and middle finger. If the condyles are to be transfixed, make a vertical incision ¾ inch long just above and on a line with the external condyle, bearing in mind that the latter and the great trochanter are in the same vertical plane. Let this incision be made while the skin is drawn upward, and pass the knife down to bone. Withdraw the knife and pass a grooved director along the incision so that it impinges against the bone. Now palpate with the point of the director to determine if the center of the bone is directly beneath; this will avoid invading the synovial pouch or the popliteal space. With the director in place, pass the steel pin (about $\frac{3}{16}$ inch diameter and 6 or more inches long) along the groove of the director until the point of the pin catches in the bone. Withdraw the director and pass the pin directly through the bone at right angles, using an augur-like handle or a carpenter's or other brace. If the pin is hammered in, splintering may occur. The assistant at the opposite side of the table makes pressure at the inner side of the limb, and when the point of the pin impinges the skin on the opposite side, an incision is made as on the outer side, and the point of the pin is extruded through this. Gauze pads wrung out in iodine water (one dram iodine to 1 pint of sterile water) are threaded over each end of the pin so that the wound is completely covered. The "spreader" is then attached, screwed into place, and a large dressing of dry gauze and cotton is then applied, special padding being placed to keep the arcs of the spreader from touching the top of the knee. The pin should be long enough so that at least ¾ inch of it protrudes on each side.

If the transfixion is to be made through the supracondyloid ridge, the original external incision is made at a point 2 inches above the external condyle, the rest of the procedure being

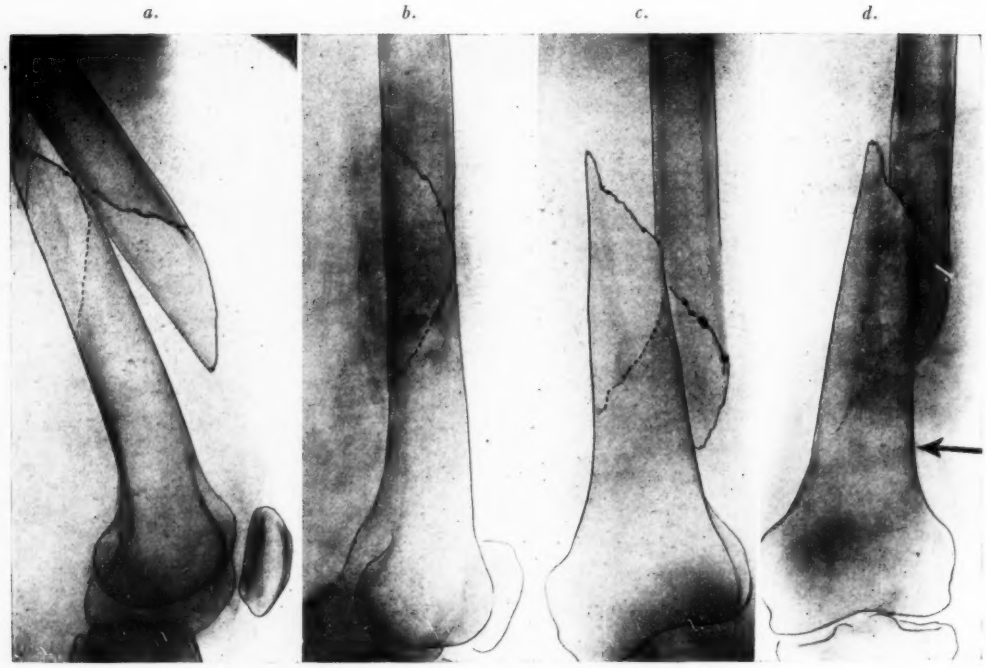

Fig. 11. Supracondyloid fracture of the femur, *a* and *c* before, and *b* and *d* after reduction. Transfixion removed from level of arrow.

identical with the preceding. When the patient is abed, the knee is flexed to an angle of 135° (midway between a right angle and full extension), the foot of the bed is elevated 12 or more inches, and a weight of 25 to 40 pounds is attached to the cord leading from the spreader over the pulley at the foot of the bed. The knees are maintained in the desired degree of flexion in a three piece mattress bed, or on an inclined plane or on pillows—both knees being at the same angle. The direction of the traction is that of the plane of the upper fragment, and the knee must be so bent that it hangs free, and the thigh must rest on a perfectly flat surface. A bent Thomas, or a Hodgen splint can be used if desired. A sock is to be glued to the foot and a cord is fastened to this leading to a pulley so that the patient may daily move his knee to the limits of extension. A bandage about the ankle with a cord passing to an overhead pulley will accomplish the same purpose. No coaptation or other splints are needed and the entire limb is exposed except for the dressing over the pin and spreader. Traction is to be maintained long enough to align the fragments and attain a fair degree of union. This usually requires a period of from 15 to 45 days. The pin will be loose enough to be readily removed if it has been *in situ* over 3 weeks, otherwise some force will be needed to dislodge it. Removal should be from within out, the protruding inner end previously sterilized by the flame from an alcohol lamp or by iodine. The wounds may appear more or less sloughy or superficially infected, but this disappears after a few dressings. A molded plaster-of-Paris or other dressing is applied after the transfixion is removed and this is worn until union is fully attained.

In a very low supracondyloid fracture, transfixion can be made through the head of the tibia, or the stirrup over the os calcis can be employed. When union is still further advanced, the patient is allowed about on crutches or in walking calipers made of a Thomas splint, the lower end of which is cut off and turned into the heel of a heavy shoe. The absence of œdema, cyanosis, and joint stiffness is very striking in cases thus treated, and I am fully convinced that union is hastened.

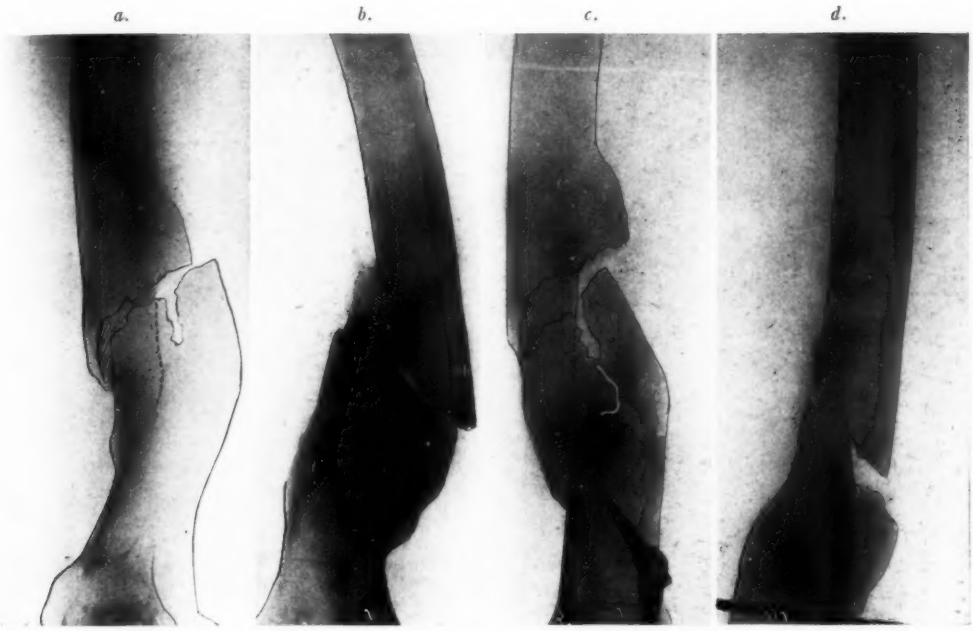

Fig. 12. Refracture supracondyloid of femur. *a* and *b*, one year after original injury. *c* and *d*, transfixion applied.

The method was first used by me in 1913 in a series of some 14 cases at Harlem Hospital; many of them in children. To date there has been one infection of the deeper parts involving the periosteum cortex, but this speedily cleared up. There have been no fatalities. In a recent case I was obliged to remove the transfixion because the patient was obstreperous and in this instance the original deformity was not fully overcome. When the procedure is properly carried out and when the patient properly co-operates, reduction is virtually assured. Overcorrection is not unusual, but this is a good fault.

The merits of the method are:

1. It requires no very great skill, no special instruments, no prolonged anæsthesia.
2. It is adaptable for home treatment or where there are no especially trained attendants.
3. The nursing care is minimized because the patient has considerable freedom and is virtually in a semi-seated position.
4. The introduction of the transfixer at a distance from the actual site of the fracture does not re-traumatize an already damaged area.
5. The safety and certainty of the method makes a happy choice by comparison with open operation.
6. It is relatively painless despite the resemblance to a barbarous custom.
7. It permits inspection of the entire limb and joint freedom.
8. It combines reduction and splinting and once introduced requires only ordinary supervision.

The demerits are:

1. Danger of infection of the bone.
2. Damage to the popliteal vessels and joint bursæ.

These are elements to be considered, but with ordinary care they can be avoided.

The Finochietto stirrup or the Chutro modification of it is the remaining form of skeletal traction. This device is passed over the concavity of the os calcis but I have not found it as efficient as the transfixion. A similar effect is obtained by passing a transfixion pin over or through the os calcis, attaching thereto the same spreader used in transfixing the femur.

Management of fracture of the femur in children less than 5 years of age is either by the overhead slinging up method of both extremities or by a plaster-of-Paris spica. Beyond this age, treatment is the same as for similar cases in adults. The deformity remaining after the frac-

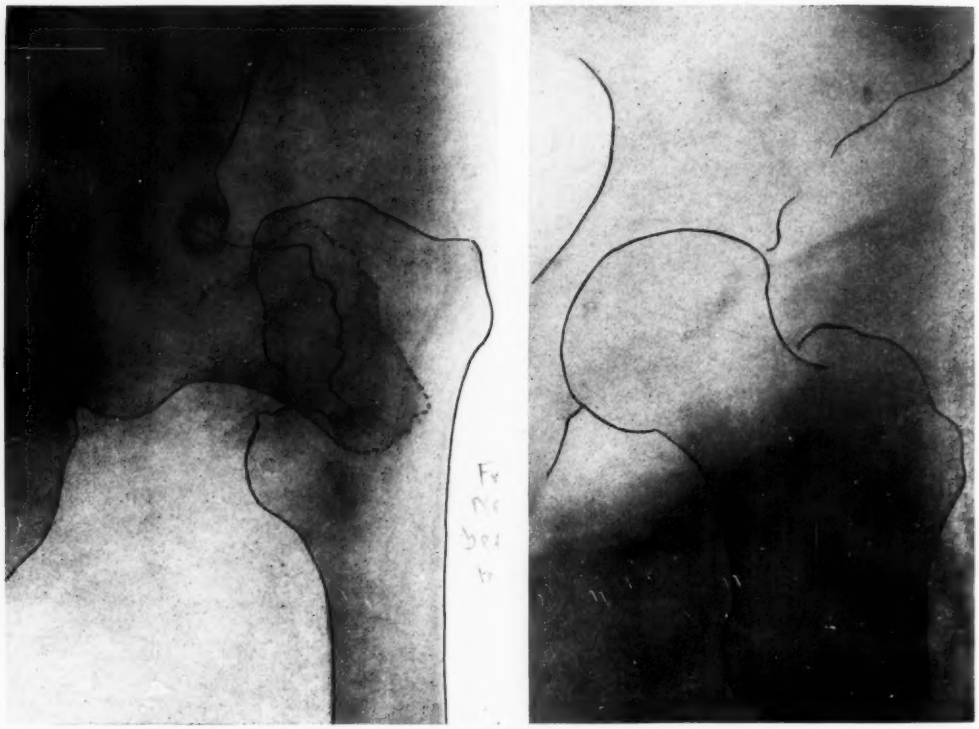

Fig. 13. *a* (at left). Fracture neck of femur before reduction. Female, aged 50. *b*. Fracture neck of femur after reduction and application plaster spica.

ture of the shaft of any of the long bones in a child under 15 is very likely to be compensated for by the normal growth; but in joint fractures this rule does not pertain, especially if the epiphysis has been involved and hence joint fractures require a greater degree of accurate coaptation than shaft fractures.

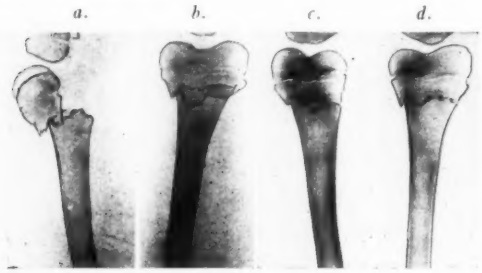

Fig. 14. *a*. Juxta-epiphyseal fracture before reduction. *b*. Juxta-epiphyseal fracture after reduction. Note unusual anterior displacement of lower fragments.

Our duty does not end when reduction is attained or union is accomplished; indeed the aftercare may be as important as the initial or immediate care. Early massage and motion are essential if we aim to prevent adhesions in joints, tendons, or muscles, and this sort of prophylaxis will forestall an end-result that may be quite as crippling as that which follows shortening or bowing of bone. Weight-bearing should not be permitted until solidity of union has been well tested by repeatedly noting the reaction to forcible massage and motion, followed by similar supervision after the patient has been allowed guardedly to walk prescribed distances. The former rule of permitting weight-bearing only after a lapse of from 6 to 12 months must be modified, if we apply a form of treatment that immobilizes the limb only a few weeks instead of 3 months. If, when we remove the apparatus, our patient no longer has an atrophy from disuse and pressure, and if there are no joint, tendinous or joint adhesions, and if there is little or no

œdema or cyanosis, assuredly that patient is ready for duty much earlier than the patient who has a united fracture but a shriveled limb, stiff joints, and tendons, and a boggy blue extremity.

CONCLUSIONS

1. Treatment of fracture of the femur starts with first aid designed to place the limb at rest in traction in a Thomas splint, or in traction straps with weights attached. Ambulance surgeons and first aid men should be supplied with Thomas splints.

2. The patient and not the fracture will demand most attention in the feeble or diseased.

3. Any method that does not combine reduction with early massage and motion fails to give the maximum service.

4. The former idea that deformity and disability are inevitable in femur fractures should be abandoned.

5. Two attempts at reduction should be made before skeletal traction or open operation is performed.

6. For the non-displaced and reducible group, plaster-of-Paris (spica or molded) is an efficient form of splintage.

7. In the irreducible group described, skeletal traction by transfixion offers safe, efficient method.

8. This fracture entitles the patient to a high grade of surgical care and exacts from the surgeon a degree of diligence and skill at least equal to that necessary in the management of many other major surgical problems.

9. Fractures have been too much slighted by surgeons and for that reason the fracture field is being encroached upon by orthopedists who by their training are better fitted for the after-care than for the initial care of this acute variety of traumatic surgery.

Fig. 15. Unreduced supracondyloid fracture of femur, end-result.

10. There is great need for standardization and uniformity in fracture work and in no group is this more necessary than in fractures of the femur.

BONE PIN GRAFTS IN UNUNITED FRACTURES OF THE LOWER JAW

By ROBERT E. SOULE, M.D., F.A.C.S., Newark, New Jersey
Formerly Major, M. C., U. S. Army, Chief of Surgical Service. U. S. General Hospital No. 41, Staten Island, New York.

SIMPLE fractures of the lower jaw with no loss of bone substance are easily controlled by properly fitted dental splints, but in ununited fractures, with or without loss of bone, other methods such as bone inlay grafts, either applied to the external surface or inserted along the inferior border of the ramus, must be employed in order to obtain bony union of the fragments.

The use of the bone inlay necessitates a wide dissection of soft tissue to expose the external surfaces of the fragments for a sufficient distance each way to permit forming a gutter for the reception of the graft. The fragments must be further traumatized by boring holes for the graft retention sutures, two to four in each fragment. The possibility of injury to dental roots and nerves must be considered as well as the careful adapting of the graft to its bed, the ramus not being thick enough or deep enough to permit of the usual freedom of application as in the case of similar usage of the inlay bone graft in fractures of the long bones.

Where the bone inlay graft is applied to the lower border of the ramus a similar dissection of the soft parts, as in the preceding technique, is necessary to expose a sufficiently accessible field. Care in this instance must be exercised in splitting the ramus from below upward so that the split fragments will hold a bone graft between them securely. Here a comparatively thin graft is necessary as there is a limit to which the longitudinal split halves can be spread without tearing off one or the other halves of the ramus. The graft is then secured in position by sutures passed through holes drilled through the fragments, from without inward, and tied over the graft, snugly apposing bony surfaces, thus securing the splint effect of the graft.

To avoid as many as possible of the objectionable features of the bone inlay methods above referred to and at the same time to secure the most satisfactory results, the writer has devised a technique, the ease, rapidity, and accuracy of application of which appeals decidedly. There is a minimum of traumatism to the fragments, a minimum of pain and discomfort to the patient following the procedure, a perfect alignment of the fragments, and an absolute fixation of the fracture.

Briefly, this method consists of drilling along the lower border of the fractured fragments from before backward with the motor drill, beginning and ending well away from the fracture itself, while the fragments are held in true alignment. The anterior fragment is previously fixed to the

Fig. 1. Case 2. Roentgenogram taken just before operation showing separation and position of fragments, upward and inward displacement of posterior fragment.

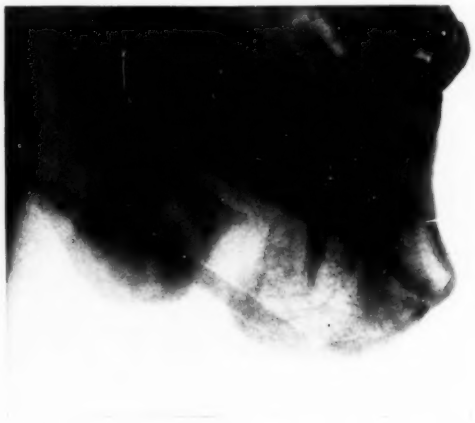

Fig. 2. Case 2. Roentgenogram taken following autogenous dowel graft insertion.

upper jaw by properly molded dental splints cemented to the crowns of the teeth and wired together to secure proper dental occlusion.

The fractured area is exposed through a skin incision, below and along the ramus of the jaw, the posterior fragment seized and drawn into proper alignment with the anterior fragment and held by bullet forceps in the hand of an assistant. The fragments are drilled for the required distance. The drill is disengaged from the motor and left *in situ* in jaw fragments while the section of cortical bone is being removed from the tibia and shaped in the motor-driven dowel shaper accurately to correspond to the diameter of the drill. The bone dowel is grasped at one end with strong forceps, the posterior fragment again held steady in position by the assistant, the drill withdrawn by the operator, and the bone dowel pin immediately inserted and driven home by a few taps from the mallet. The diameters of the drills I have used are three-sixteenths and one-fourth inches with dowel shapers to correspond, depending upon the age of the patient and the thickness of the jaw fragments. Should the judgment of the operator deem it advisable, a second dowel can be inserted above the first and in the same manner.

No graft retention sutures are required nor further traumatism to jaw fragments. The soft parts are drawn down over the field operated upon and the skin sutured by continuous subcuticular or mattress suture, suitable dressings applied, and tube feeding or soft feeding instituted as space between the jaws will permit.

CASE 1. J. D., age 3 years. As the result of a fall three months ago, there was an ununited fracture of the lower jaw at the position of the second incisor and canine tooth, right, which were lost.

When brought to my attention the patient showed a sinus discharging externally from the seat of fracture. There had been an attempt to fix the fracture by wiring the fragments, which attempt had failed. There was poor occlusion of the teeth and consequent distortion of the face.

The wire was removed and sinus healed, following which a three-sixteenths inch bone pin graft removed from the patient's tibia was imbedded by the writer's previously described technique, securely fixing the jaw fragments. The patient left the hospital in 12 weeks, with firm union of fragments and good dental occlusion.

CASE 2. A. N., age 19 years. Ununited fracture lower jaw, right, result of machine-gun bullet wound 9 months ago, penetrating also the left cheek and breaking out several teeth in upper left jaw, also lacerating the tongue. The patient was also wounded by machine-gun bullets in four other parts of the body, two in the right leg, one in the right hip and one in subclavicular space with exit through the axilla. He was taken prisoner and the bullet in the hip removed in a German hospital. Three months later he arrived in an Allied hospital where his jaw was operated upon with improved function.

When the patient was brought to my attention the tongue was found to be healed to the jaw scar on the right side, interfering with speech and deglutition; right jaw showed nonunion and loss of about one-half an inch of bone substance and also four teeth with displacement upward of posterior fragment marked loss of dental occlusion and of symmetry of facial contour.

The tongue was freed, and a bone pin graft, one-fourth of an inch in diameter, removed from the tibia, was inserted, using the writer's technique previously described. There was little disturbance following operation and the convalescence was uneventful. X-ray taken 3 weeks after the bone implant was made shows graft in good position. Eight months later union was firm.

A METHOD OF APPLYING RADIUM IN CASES OF ŒSOPHAGEAL CANCER

By P. P. VINSON, M.D., Rochester, Minnesota
The Mayo Foundation and Mayo Clinic

THERE is no condition in which the prognosis is more grave than in carcinoma of the œsophagus, and, since such cases are of relatively frequent occurrence, anything that offers the unfortunate patients the slightest chance of cure should be thoroughly tested.

Radical operations on the œsophagus, in an effort to remove the growth, have been uni-

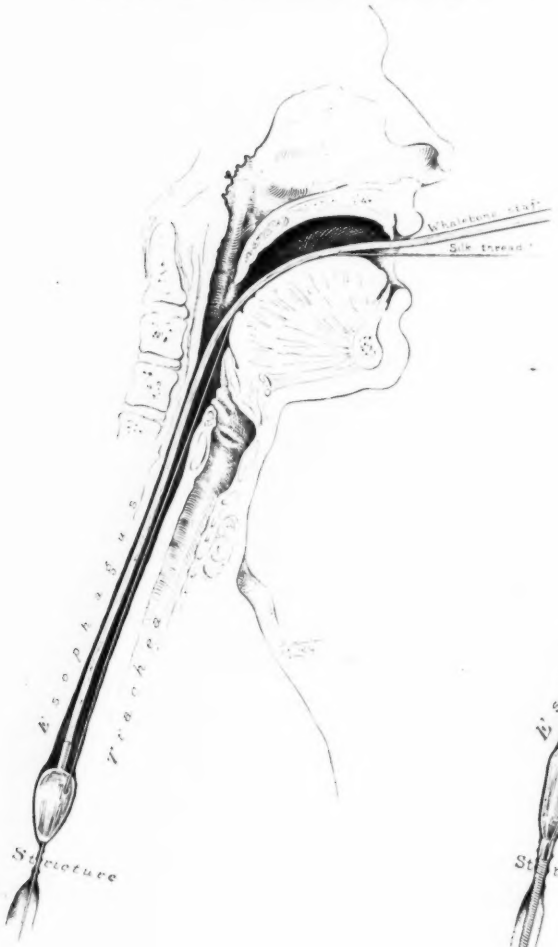

Fig. 1. Measuring the distance of the obstruction from the incisors.

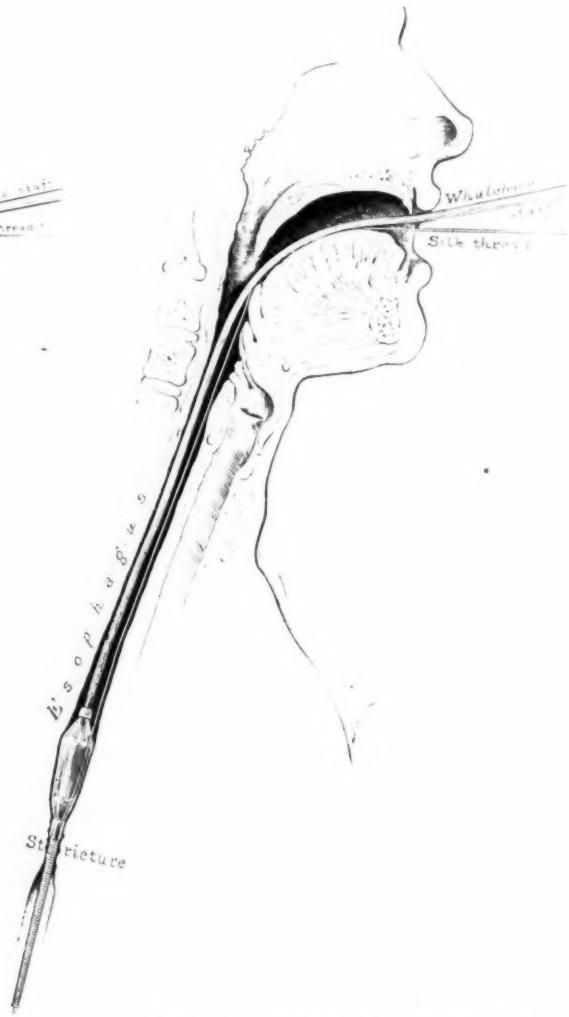

Fig. 2. Dilating olive guided on the thread by a flexible spiral.

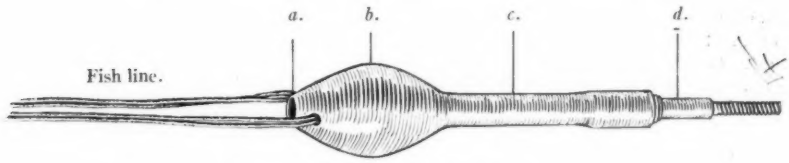

Fig. 3. Main portion of the apparatus.

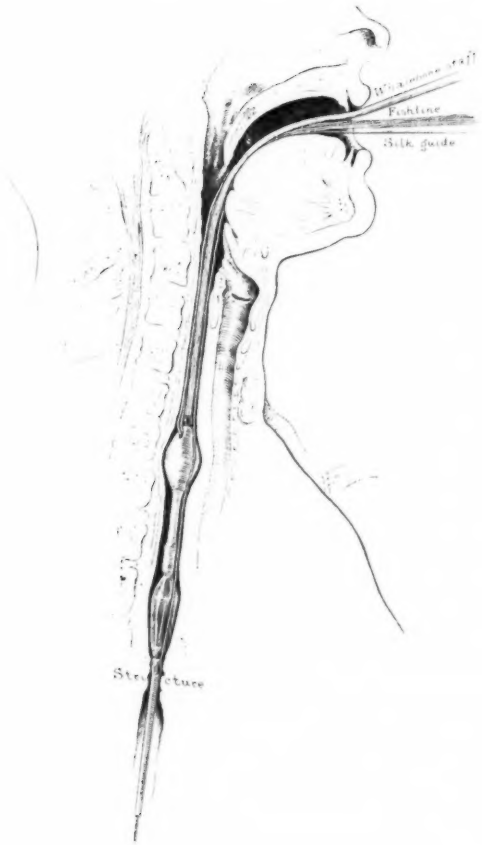

Fig. 4. The apparatus just before passing the distal olive through the stricture.

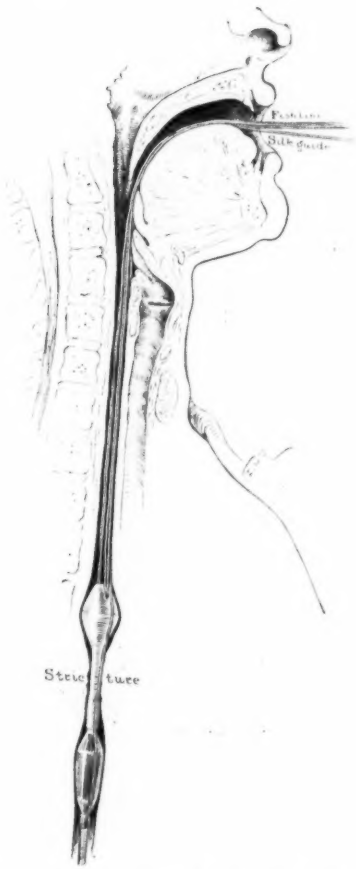

Fig. 5. The apparatus in place. The whalebone staff has been withdrawn.

versally unsuccessful owing to the inaccessibility of the lesion and the usual poor general condition of the patient. Dilatations afford only temporary benefit, and gastrostomy is a nuisance both to the surgeon and to the patient; at best it simply prolongs a most unhappy and hopeless existence.

In an effort to help some of these patients who are in seemingly hopeless conditions, we began the use of radium in selected cases in which the lesion was not extensive.

The majority of patients who come under observation have had such restricted diets that they are very weak, and it is advisable to dilate the stricture forcibly so that food may be taken before treatment is begun. Treatment is not attempted on any patient who has complete œsophageal closure, and who is unable to swallow the silk thread which is so necessary as a guide in œsophageal instrumentation.

The patient first swallows four or five yards of silk thread, button-hole twist, as described in previous papers by Plummer.[1] With this as a guide a plain olive (Fig. 1) on a whalebone staff is passed down to the stricture and the distance of the obstruction from the incisors is carefully noted. No attempt is made to dilate with this olive. The dilating olives are then used as shown in Figure 2; a flexible wire spiral guides the olives on the thread. The previous measurement on the staff shows when the spiral has passed the stricture and pressure can be made without fear of puncturing the œsophagus, a frequent complication occurring in the blind instrumentation of the œsophagus. After the dilatation has been carried to 40 or 50 F., the patient is urged to take fluids and semi-solid food for several days before treatment is begun. For the first 24 hours the dysphagia may be as noticeable as before the dilatation, but after the traumatic œdema subsides, there is usually a marked amelioration of symptoms. Following this, the radium exposures are begun by the aid of the apparatus devised by Plummer.

The main portion of the apparatus (Fig. 3) is made of brass; *a* shows an opening into which a whalebone staff fits rather snugly, but not too tightly. At its margins are two small perforations through which is passed a doubled heavy fish line. It is essential that the margins of these perforations be smooth in order that they may not cut the fish line. *b* represents a solid knob about 55 F. in size. *c* is drilled out so that the walls are 1 millimeter thick, and this section is 7 millimeters wide and 4 centimeters long. The radium is placed in this cavity and *d* is screwed fast. Onto *d* is screwed the dilating olive and spiral, using an olive large enough to necessitate some force in passing it through the stricture. The distance of the growth from the incisor teeth is measured from the distal end of the dilating olive on the staff and the measurement on the staff is marked by a piece of adhesive.

The apparatus is passed down the œsophagus, guided by the swallowed thread, and when the measured point is on a level with the incisor teeth the obstruction is noted (Fig. 4). Moderate pressure forces the dilating olive beyond the malignant process, and after passing it down 3 inches, another obstruction is encountered. This is *b*, the knobbed portion of the apparatus made large enough so that it will not pass through the stricture. The lower olive prevents the instrument from passing up, and the upper prominence prevents it from going down (Fig. 5). Thus it remains in position for as long as is desired. The staff pulls out and the long fish line is left hanging outside the mouth. When it is desired to discontinue the exposure, the instrument may be displaced upward by firm, slow pulling of the heavy thread. This is facilitated by making the pull over the index finger inserted far into the oropharynx. The first exposure is usually of from 3 to 4 hours, and later exposures are from 14 to 16 hours, using 50 milligrams radium salt, or its equivalent in emanations. About three exposures are used at the present time, in addition to the Coolidge tube treatments. Larger doses may be used at a later date.

The patient is perfectly comfortable with the radium in place, and the only complaint made after the treatment is the ordinary soreness in the throat which usually accompanies such manipulations.

Sufficient time has not elapsed to report any results from the use of radium in cases of œsophageal cancer, but these will be reported later.

[1] Plummer, H. S. The value of a silk thread as a guide in œsophageal technique. Surg., Gynec. & Obst., 1910, x, 519-523; Technique of the examination of œsophageal lesions. Tr. Sec. Surg., Am. M. Ass., 1910, 345-353.

THE TREATMENT WITH RADIUM OF CANCER OF THE BLADDER

With Report of a Case

By HOWARD A. KELLY, M.D., F.A.C.S., and ROBERT M. LEWIS, M.D., Baltimore

IT is but a short time since a patient suffering with hæmaturia rested in the hands of the general practitioner or internist, attributing such remissions as she might enjoy to the medicine she chanced to be taking. Great stress was laid on the importance of examining the urine to determine the source of the bleeding. If the blood was bright red, the lower tract was responsible; while if the blood was intimately mixed with the urine, or if ureteral clot casts appeared, the kidneys or ureters were held guilty, and appropriate medication was prescribed. Now, however, for two decades cystoscopy and the ability to examine the ureters and kidneys has, let us give thanks as we declare it, entirely altered not only all former methods of diagnosis but of treatment as well, and treatments have become direct, purposeful, and aggressive.

Of the various causes of blood in the urine, a bladder tumor is the commonest. In the older days there was no treatment for this condition, but with the modern development of surgery, running *pari passu* with diagnosis, it has been found possible to resect the bladder with the tumor in occasional suitable cases, and fairly good results have been secured. For three reasons, however, radical excision can not always be the method of choice; the operation may be impossible on account of the site and extension of the growth. The operation is often formidable and dangerous, considerations of age and physical condition having weight, and again it is followed by recurrence with notable frequency.

Beer's attack upon bladder tumors with high frequency current was epoch-making. It has the great advantage of being nearly free from risk, and frequently yields brilliant results when applied to benign papillomatous growths. It is regrettable that high frequency has not also helped us as we at first fondly hoped, in attacking malignant tumors as well. In a large percentage of these cases the growth is found on the trigonum, which also prohibits any attempt at removal, as experience shows that recurrence is well-nigh universal.

In radium, however, our experience has shown that we have an effective means of treating at least some of these malignant growths of the bladder.

Let us describe the method and cite a case in point. The simplest plan consists in a direct application of the tube containing the radium or emanation to the tumor. This is most easily and satisfactorily accomplished in the case of a woman through the Kelly cystoscope. With the patient in the knee-chest posture and an air-distended bladder, one can see the growth as easily as the uvula in the mouth, and can also just as easily apply the radium on the end of a sound close against the tumor. In this way we have treated a number of cases of vesical carcinoma with some excellent results.

As a rule the emanation equivalent of a gram of radium is used, and the treatment is given for from three to ten or more minutes. Vesical irritation is not noted unless the applications are made directly to the infiltrated vesical wall. Such treatments can be given from one to four times in a fortnight. Raised papillary malignant tumors of the bladder can also be handled by direct applications of radium on the surface, with a good chance of getting a satisfactory permanent result.

As a rule the application of radium checks the bleeding promptly; if it fails, a superficial fulguration of the oozing area ends it.

The infiltrative type of bladder cancer is confessedly harder to handle, and its treatment calls for unusual judgment and nicety in methods of attack. In a woman with a trigonal involvment, the infiltration is often felt and outlined through the vaginal wall, and here we can easily establish cross-fire treatment, increasing greatly the direct radiation of the diseased area and avoiding irritation of the bladder mucosa. The application of a gram of radium at one-fourth or one-half inch distance from the vaginal wall for from one-half hour to 2 hours, in addition to the intravesical treatment, would constitute an average radiation. This can be repeated in from 4 to 6 weeks. If the amount of radium used is less, the duration of the treatment should be correspondingly longer.

Finally, we have a third useful means of radiation at our disposal. Instead of applying radium or emanation over the bladder or vaginal side of a growth, one can implant a capillary glass tube containing emanation directly in it. For

this purpose one of us (R. M. L.) has devised a special instrument described in a previous article. Usually 5 centimeters or more of emanation is imbedded and permanently left in place.

A short summary of a case of infiltrative bladder carcinoma, now apparently well, serves to illustrate the general scheme of treatment.

On January 18, 1919, patient, woman, age 59, W., was referred by the courtesy of Dr. W. Sinclair Bowen, Washington, D. C., giving a history of the passing of bright red blood in the urine for three months, present every time on voiding; nycturia 3; no pain. No uterine or other hæmorrhage; otherwise well.

Cystoscopic examination: knee-chest position, Kelly cystoscope; Vertex, posterior wall, right and left walls normal. On base, beginning at internal orifice of urethra, on the inter-ureteric ridge, is a dark colored, bossed, ragged growth, encroaching on the left ureteral orifice, about cherry size, measuring 2/5 centimeters antero-posterior, and about 3 centimeters from side to side, and extending from urethra in front, back to left lateral wall. Constant bleeding makes view difficult. On vaginal examination a hard growth the size of a lima bean is felt in the anterior wall to left of mid-line behind the trigonum; otherwise vagina and pelvic organs appear normal.

Treatment: January 21, 1919, 4 areas of the growth were treated by direct application of tube containing 1167 mc. of radium emanation, 1 minute each. January 22, 1919, 1029 millicuries were applied to vaginal wall behind the growth. Filtration ½ inch of felt, brass tube 2 millimeters in thickness.

January 24, 1919, 1167 millicuries were applied directly to one area in the bladder 3 minutes in brass tube.

February 7, 1919, 676 millicuries were applied on sound 2½ minutes, intravesical treatment.

February 17, 1919, vaginal examination shows mass 3 by 2 centimeters in the anterior vaginal wall.

March 3, 1919, examination shows separation of a slough and diminution in size of area of ulcer. Treatment, 344 millicuries 4 minutes, applied to growth in bladder.

April 1, 1919, 100 millicuries in an open-ended sound, greatly reducing the usual filtration, applied directly to growth for 2 minutes through the Kelly cystoscope. Cystoscopic examination shows great improvement. The area of infiltration is 1¼ by 1 centimeter in size. On vaginal examination the nodule is felt to be about ¾ by ½ centimeters.

April 22, 1919, 212 millicuries on sound was held directly to the growth in the bladder for 5 minutes.

May 1, 1919, 199 millicuries in open-ended sound 1 minute against tumor, through the cystoscope. Again the growth is noted as much smaller. Nothing felt on vaginal examination.

June 13, 1919, nothing felt on vaginal examination. Cystoscopic examination shows on left base near vesical cornu a small granulation 5 millimeters in diameter; adjacent to this a linear white scar, 2 centimeters long. Treatment to area of granulation 583 millicuries on sound for 5 minutes directly against the tumor.

July 24, 1919, bladder entirely normal except for white scar at site of former disease. Treatment, 972 millicuries to scar 4 minutes. Since this time we have seen patient at intervals. She has continued entirely well up to the time of writing (February 13, 1920). There has been no further hæmaturia and do frequency of voiding.

TRANSACTIONS OF SOCIETIES

CHICAGO SURGICAL SOCIETY

REGULAR MEETING HELD FEBRUARY 6, 1920, DR. CHARLES F. KAHLKE, PRESIDING

ACTINOMYCOSIS OF THE LOWER LIP

DR. JOHN R. HARGER: This man is 53 years of age, and came under my observation a few months ago. He gave a history of having been on a farm for 3 or 4 weeks last August, visiting his son. Previous to this time he had been in good health. About the middle of October he noticed a lump in his lower lip on the left side. This lump increased gradually in size. It was not painful, but a little tender to touch. Eventually, however, it annoyed him because it reached a size sufficiently large to project a little. Examination showed the mass to be about the diameter of a quarter. It was not attached to the mucous membrane nor skin; it was not circumscribed; it was slightly tender; it did not fluctuate, and did not seem to be quite hard enough to be malignant. As it was not attached to the mucous membrane or skin, I did not think it was malignant, but thought it might be inflammatory in character. I advised him to have a little of the mass removed for section. I removed a piece and found distinct signs of inflammatory action. It was not circumscribed and manipulation caused a whitish, purulent material to escape. I did not remove a V-shaped piece of the lip because I did not think it was malignant, but I did remove a small amount of mucous membrane to provide for a better closure of the wound. Microscopic section showed the ray fungus. The man apparently had contracted the infection during his short stay on the farm.

I have brought this man here for two reasons: First of all, because of the rare condition, and because I am seeking information. So far as I can ascertain, treatment in such cases is not satisfactory. I believe that if this infection should recur I would advise the patient to have a complete resection of the lip. At the present time there is no evidence of recurrence and only a small scar on the lip is seen. I would like to inquire if any of the members have had experience in treating cases of actinomycosis with radium or X-ray.

DR. PHEMISTER: Has the patient been given any iodide of potash?

DR. HARGER: Yes, but he has not been very faithful in returning. When he came back the first time he showed no evidence of a recurrence, and I have not pushed the iodide of potash.

DR. A. J. OCHSNER: Some twenty years ago we learned through Professor Bollinger who had been a veterinary surgeon that if we treat cases of actinomycosis exactly as the disease is treated in cows, the patients will recover just as regularly. If patients with actinomycosis are given enormous doses of iodide of potassium, say 90 grains at each dose three times a day, 8 hours apart, in half a pint of milk followed immediately by a pint of hot water, the remedy will get into the circulation promptly without causing gastric disturbance. This should be done for four days, then omitted for a week, and then repeated again until there has been no sign of the disease for at least one month. These cases will get well in our experience if this plan is carried out. Small doses of potassium iodide do no good.

We had two cases of actinomycosis last week, one abdominal and one of the neck, and they are responding to this treatment very promptly.

It is important to repeat this treatment once or twice a month after the patient has apparently completely recovered, in order to destroy any stray points of infection which may not have been reached during the primary treatment.

In two cases in which this after-treatment was neglected we had recurrence because there was evidently an abscess which contained the ray fungus or its spores at a point to which the blood stream had not carried the potassium iodide.

DR. KELLOGG SPEED read a paper entitled, "Carcinoma of the Pancreas."

OSTEOMYELITIS

DR. A. J. OCHSNER read a paper on osteomyelitis. (See p. 263.)

DISCUSSION

DR. CARL BECK: There are very few surgeons who have had the experience of Dr. Ochsner in regard to acute osteomyelitis. I have had comparatively little experience with cases of acute osteomyelitis, but I have studied very carefully the subject of chronic osteomyelitis.

In the history of osteomyelitis Celsus has a very interesting chapter on this subject. He speaks of a swelling appearing on the lower portion of the leg, and says that the swelling festers. He takes his probe, goes in and finds rough bone and says that bone is diseased and dead, and a hot iron must be inserted in the cavity and the tissue burned until

the dead bone works out. Healing, he says, will not take place until all dead bone is removed. That is a crude way of describing the same methods we are employing today.

It is also interesting to note that Pasteur was one of the first to recognize and speak of sore throat, carious teeth, and other local infections as causes of osteomyelitis. In one of his early works Pasteur spoke of what he called osteitis furunculosa. From a furuncle on the hand an abscess developed in the bone, and he speaks of furunculosis of the bone. Quite a number of modern authors have also quoted this observation. Scientifically and technically it has been developed only in the last few years by Rosenow and experimentally demonstrated as correct.

As far as therapy of acute osteomyelitis is concerned, the treatment described by Dr. Ochsner is ideal. Very often bone that seems absolutely dead and useless, the removal of which will cause an opening of channels through which sepsis may be transmitted and death follow, will recover.

In chronic cases I have also followed the older methods of treatment by the Mosetig-Moorhof plug and have not been successful, and I have come to the conclusion that a cavity in a bone, after all necrotic material has been removed, cannot be successfully made aseptic. It may be possible in a very exceptional case to make it aseptic, but absolute asepsis cannot be assured by any process, neither by fire nor by chemical, because such agents do not pentrate deeply enough to destroy the infected material. Therefore, I have long given up any attempt to close such cavities with any foreign material.

In a recent number of the *Annals of Surgery* there appears an article by Martin who implanted fat into such cavities. This method under rare conditions may be successful. The cavity may also be filled with blood clots.

In our experience we have found it absolutely necessary to reduce a cavity to a surface, whether by the use of epithelial skin flaps or skin grafts. Secretion must be stopped in order to heal the cavity. In many instances this is difficult to do. In a cavity of the femur, tibia, or humerus, it is easy, but when you have to deal with an osteomyelitic cavity close to a joint, or osteomyelitis of the spine or ribs, it is sometimes very difficult to obliterate the cavity. The introduction of flaps along channels is almost impossible.

I showed those who visited our clinic this morning two interesting cases from which I learned a new lesson in dealing with these cases. The operative treatment of fractures has become more frequent. Many surgeons, as you know, operate early, and as a result of their surgical manipulations produce osteomyelitis which is harder to heal than osteomyelitis from infection. I stated this morning that I should judge about 10 per cent of all cases of osteomyelitis coming under our observation are due to badly treated fractures. The result is newly-formed bone and a lot of cavities around the fractured ends of bone, and these are very difficult to heal. I have learned that it is necessary sometimes to cut all of the muscles. In one case this was done with the anterior muscle of the femur in order to get down to the cavity. In another case I cut all muscles from the side of the femur in order to make the cavity as shallow as possible in treating the osteomyelitis.

It is difficult to treat a cavity of the hip-joint. I had a case of osteomyelitis on which the late Dr. Senn operated eighteen years ago. Following his operation of removal of the head of the femur the girl had a chronic osteomyelitis with a discharging fistula of the hip-joint. It would not heal until I removed the lateral portion down to the osteomyelitic cavity, which was closed by a flap.

Dr. Edwin W. Ryerson: My experience with acute osteomyelitis is quite limited. I have treated perhaps 22 or 25 cases. I was much interested to hear what Dr. Ochsner had to say about splitting the periosteum. It hardly seems to me offhand that it would be a rational thing to do because the focus of infection is in the medullary cavity, and I should think an opening ought to be made through the cortex of the bone; but his results are so convincing that at my next opportunity I shall try it. In many cases of acute osteomyelitis we have attempted to do too much. It should not be done, as Dr. Ochsner and Dr. Beck have said. We should give the bone a chance because the reparative properties of bone are excellent, even in the presence of infection. In a case of osteomyelitis of the tibia, I should feel more like making a narrow cut through the cortex of the bone to the limit of the extent of the disease. It would seem to me that would be a little safer, but Dr. Ochsner's conclusions are very interesting and well worth considering.

With reference to chronic osteomyelitis, it is one of the most striking examples in surgery of the differences of opinion of different operators. A number of years ago I read a very comprehensive, careful, well considered article by Simmons, of Boston, which was published in the *Boston Medical and Surgical Journal*, in which he expressed the belief that if we could select the proper time for taking out the entire shaft of the bone which was osteomyelitic, we should get in every case a complete reformation of the entire shaft of bone. I have seen three cases of complete reformation of the entire tibia in which the bone was entirely destroyed to the epiphyses. The epiphyses are never involved, at least early, in the disease, and it is always limited to the diaphysis. In these three cases of which I have personal knowledge, the entire tibia was reformed. In another case upon which I operated we did not get a reformed tibia, and it was evident we had waited too long and expected too much of the osteogenetic remains of the bone. That case had to be treated by bone grafts, after a complete craterization of the cavity, reducing the cavity to an open, almost flat surface, which forms the

most important part of the modern treatment of chronic osteomyelitis.

The reason the Mosetig-Moorhof spermaceti plug has failed so often in the hands of those who have used it is because it is almost impossible to stop the bleeding in the thick shaft of the bone which we have exposed. I have tried it very often and have never yet been able to stop the bleeding, completely, and if you put in a Mosetig-Moorhof plug and allow bleeding to take place underneath, there is always a failure. It is impossible, as Dr. Beck says, for us to clean out all the infective foci in the shaft of the bone; you can nearly do it, and you think you do it by chemicals or heat, and yet the various methods of filling bone cavities at the time of operation with spermacetic compounds, or paraffin, or petroleum compounds, almost always fail. We had a good many cases at Fort Sheridan operated on by various men A series of cavities were filled with living material, pedunculated flaps of muscle or fat being used. This is more rational than to allow such cavities to fill with blood clot, because a blood clot, after it has once clotted, has very little resistance. It does not resist infection, while living muscle will resist infection to quite a marked extent. If we simply put skin into these deep cavities, as in the tibia, the result is an adherent scar. The skin is apt to be so adherent as to cause the patient inconvenience. I think however, filling up the cavity with skin is much better than not filling it at all.

I am not optimistic about the old cases of osteomyelitis of the femur because I have seen some that had been operated on many years ago by some of our most distinguished surgeons These cases are still discharging and still need proper craterization, but a man rather hesitates to take out half of an osteomyelitic femur, which is what should be done to cure the case. You dislike to do it and you content yourself by taking out a narrow canal of bone which does not work. If you have an osteomyelitic femur you may as well take a motor saw and split the femur in half, all the way up, and leave only a shallow canal for the other half of the bone. These cases will usually then get well if you drain them properly for a long time.

Dr. John R. Harger: I would like to say a word or two regarding Dr. Ochsner's explanation of recurrence in chronic cases of osteomyelitis. I have had several cases of chronic osteomyelitis in the past year that have extended over a period of from 10 to 25 years. Dr. Ochsner offered the explanation that these recurrences were probably due to foci of infection in the teeth or tonsils. It seems to me they were more likely due to latent foci of infection in the bone. In chronic osteomyelitis the shaft of the bone is increased in density; the blood supply is much more limited than in normal bone, and the chances for infected emboli to enter has very much decreased. However, should they enter, the bone would likely be more susceptible to infection.

In closing these cavities, I have found invariably that if the cavity is reduced to a surface and filled up in some way with soft living tissue, whether muscle, fascia, or skin, it will close.

Recently I had a case which extended over a period of 21 years, with an acute exacerbation in the end of the tibia, so dangerously near the knee-joint that I felt very much afraid it would enter the joint. It was located back of the tuberosity so near the joint I could not reduce the cavity to a surface. I took a portion of the fascia, muscle, and fat along the outer side of the leg, leaving the pedicle attached at the knee and filled the cavity. The flap lived and granulated sufficiently to fill the cavity. This was done 3 months ago, and the cavity is still closed.

Dr. Coleman G. Buford: Some years ago I had a subperiosteal resection for osteomyelitis in which regeneration was incomplete near the middle of the shaft and it was necessary to put in a bone graft to fill the gap. The tibia which had thus far regenerated, was weak and thin and after the insertion of the bone graft, was unfit for full weight bearing, but after a little use, bone hypertrophy rapidly took place and the shaft became much larger and useful. There was almost no subsequent longitudinal growth of this regenerated diaphysis, but the fibula grew and its head became displaced upward, giving the appearance of an angulated bow leg. I found that I could repair this deformity in part, by cutting the tibia transversely, making traction, thus bringing down the head of the fibula and elongating the tibia and straightening the leg. A bone graft was inserted in the tibial gap; I thought that this would have to be repeated from time to time until full growth was established. As far as our work went, this case was a success, but we finally lost track of the patient.

I quite agree with the remarks of Dr. Beck, and while I have tried everything suggested to fill the craters, covering a period of 25 years, I have failed many times to obtain permanent healing, but began to have very much better success after I learned either to remove the diaphysis in cases where the bony shaft was almost or wholly damaged beyond fair prospects of repair or to reduce the cavity to a surface, the plan suggested by Dehelly who addressed us several months ago. In such extensive cases of osteomyelitis of the shaft, three planes are removed by the chisel or circular saw. The soft parts fall in and regeneration begins. Last July I operated upon a boy who had been suffering from diffused osteomyelitis of the shaft of the tibia for many months. I did the operation I mentioned, leaving the posterior plane of the tibia only, and was much surprised at the rapidity with which repair took place. In a comparatively short time a new tibia had regenerated, almost perfect in shape and size.

Dr. Ochsner has given us a very valuable lesson in osteomyelitis in connection with the matter of splitting the periosteum. When he first called my attention to it a good many years ago, I looked upon the method with some misgivings, but later a

child was brought into the hospital with diffused involvement of the shaft of the humerus. From the X-ray picture I thought that the entire shaft was dead. The child's life certainly appeared to be in great danger, and it seemed to me that nothing less than a total resection of the diaphysis, leaving the wound open, would result in saving this child. The parents refused all treatment except incision. I made an extensive incision of the periosteum as advised by Dr. Ochsner and to my astonishment the patient recovered. At one time the wound was all healed over and his arm very shapely, but later a sinus appeared from which I extracted a small sequestrum, after which it healed.

DR. KELLOGG SPEED: I have never published a paper on the subject of acute osteomyelitis but in 1914 I operated within a few weeks 5 cases of acute osteomyelitis, 4 of the humerus, and 1 of the femur. Based on the pathology of a rapid extension of the process in the medullary cavity, as shown in the specimens, the periosteum was reflected, and there was performed complete subperiosteal resection of the shaft. Two of the humeri developed perfect bone, perfect arms. The third was nearly perfect, and 9 months afterward the patient fell and broke the newly formed shaft and it reunited in due course. In the fourth humerus we had more or less bony regeneration, but it was not perfect. The femur case was not satisfactory, and a bone transplant had to be inserted later.

At that time I formulated certain rules of my own, and they were about as follows: First, when a bone is subperiosteally resected, extension must be put on the limb to keep it stretched out to its former length, for obvious reasons. In putting stress on the periosteum you stimulate it. The periosteum should be kept dilated and distended at or about its former size, stimulating the formation of bone from the cambian layer, so that new bone will approximate old bone in size. We do that by packing gutta percha in the periosteum. Some operators sew the periosteum together; it collapses and makes a fibrous band in a few weeks. It must be dilated in a position of physiologic activity. These cases must be kept in extension for a long time until bone forms firmly enough to take up the stress of muscle contraction.

After operating on these five cases, I have not performed complete subperiosteal resection on any case since. I believe what Dr. Ochsner tells us, that dead bone acts as a splint and will take care of itself in the process of regeneration. I think a gutter should be made and the bone drained in the manner that he described.

DR. CARL B. DAVIS: In resecting the entire diaphysis of the shaft in children and in adults, I should like to call attention to a paper by Stiles, read at the Los Angeles meeting of the American Medical Association, and published in the *Journal of the American Medical Association*, in which he gave the statistics of numerous cases of resections of various types, and showed that the tibia and other bones will regenerate when the shaft is taken out from one epiphyseal line to the other. We ought to differentiate between children and adults in considering these cases. In the majority of cases in children the bone will regenerate when the shaft is taken out from one epiphyseal line to the other, but in most adults this will not be the case.

DR. ROGER T. VAUGHAN: In most articles on osteomyelitis one does not see much written about the pathology found in the different cases, and there is not much said usually about how to handle the different varieties of acute osteomyelitis. The tendency seems to be for the individual surgeon to treat all his cases alike. I see every now and then such cases as Dr. Ochsner has described where there is pus between bone and periosteum, but no focus in the bone itself so far as one or two exploratory drillings indicate. In such cases I am at a loss to know whether I am dealing with a suppurative periosteitis or whether there is some small focus of osteomyelitis present which I have failed to locate and ought to hunt for further. If we are dealing in such cases with a suppurative periosteitis merely, of course there is no particular necessity of opening up the marrow of the bone, but when exploratory drilling reveals medullary pus, I have hitherto followed the commonly accepted practice of opening up widely and draining.

In a second type of acute osteomyelitis one finds on splitting open the periosteum that pus is oozing in droplets from the surface of the bone—"sweating pus" as it has been called—such pus is evidently under pressure from the inside of the bone and when pus is under pressure I cannot help feeling that the abscess cavity ought to be laid wide open and the pus evacuated freely. That has been my practice in such cases up to the present time.

There is still another type of bone pathology in which subperiosteal pus is found. The pus may be seropurulent, serohæmorrhagic or thick and purulent; but when the cortex of the bone is chiseled away no bleeding takes place from the medullary cavity which appears red and hæmorrhagic instead of normal fatty or lymphoid marrow. I interpret this finding as a medullary thrombosis. What should one do in a case like that? Is pus going to be formed eventually and should the whole medullary cavity be opened wide, or should we be satisfied to pack only the external wound and leave the thrombosed mass undisturbed? I am in a quandry about such cases and have tried both methods without seeing much difference in the results. I should like to know what Dr. Ochsner does in such cases. Certainly he would be justified in not opening up the medullary cavity in such cases if he could be certain that medullary suppuration would not ensue.

DR. NORMAN KERR: I would like to speak of our experience in Hospital No. 41, where we had about 50 cases come under our observation. In the first place, we injected the osteomyelitic focus with zinc chloride, followed by 20 per cent alcoholic solution of methylene blue stain. Then we did the radical operation, as explained by Dr. Beck and Dr.

Ryerson, of using a flap, if necessary. In three such cases we had sudden death, so that since that time we have not used zinc chloride solution unless a constrictor was used above the seat of the disease. As I have said, we had three sudden deaths and there were also three at Atlanta, during Dr. Babcock's absence. He reported at a meeting of the American Medical Association, as you may remember, 68 cases that were successfully treated, and there have been a few instances in which the wound did not close, although the patients were almost ready to be discharged. We had a similar experience in General Hospital No. 41. With the exception of the three deaths in our 50 cases, healing occurred inside of 6 weeks.

At Fort Sheridan I have been trying out the method of injecting with 14 per cent zinc chloride solution and then staining with methylene blue solution. I had the contents of the cavity sent to the laboratory in several cases to see if it was sterilized, and a report was sent to us stating that this material was not sterile. We found, however, every one of the them showed cultures, so that while I believe the method has some virtue, still it must not be depended upon absolutely.

We also had a series of three cases with good results from the use of chemical sterilization by 5 per cent carbolic acid in alcohol. The cavities closed up entirely. In one case of osteomyelitis of the shoulder in which nothing was used, the cavity closed up immediately. After all, the whole question simmers down to efficient removal of bone, and good clean surgery.

Dr. Ochsner (closing): Dr. Kerr's discussion is very interesting. I have followed the observations of men in different places, and it looks to me as though Babcock's results were quite extraordinary; but the element of danger Dr. Kerr has mentioned must be considered.

Dr. Davis has drawn our attention to the treatment of this condition in children. It is surprising how bad osteomyelitis may appear in a child, and yet how perfectly healing will take place by simply making an incision through the periosteum, being sure to split the periosteum much farther than seems necessary. In young children, no matter how large a portion of bone is removed, this may be restored without much deformity, although the infection may have been extensive to begin with. It is true that in some children the dead shaft of the bone can be safely removed early if care is used not to scrape the bone producing the layer of the periosteum. According to our observation the new bone obtained after removing the entire shaft early cannot be compared with the bone that is produced when simple drainage is used and the formation of an involucrum awaited. Even with a lot of trouble, not nearly so good a result is secured as in the other way. All seriously sick patients I would treat by simply making a very long incision down through the periosteum and loosening the latter on each side for a distance of 1 centimeter. When there is oozing of pus in acute cases, as mentioned by Dr. Vaughan, nature has established very good drainage, provided the periosteum is split freely, that is, the pus is forced out from the haversian canals underneath the periosteum, and there it is held. If the periosteum is opened the pus is no longer held under tension, and by using boric acid and alcohol dressings and establishing drainage outward, the amount of destruction will be relatively small.

In operating for the relief of chronic osteomyelitis, the limit of the infected tissue must be reached. In acute osteomyelitis it is sufficient to establish drainage by splitting and reflecting the periosteum. When a circumscribed area of infection is located in the medullary cavity without much traumatism, a favorable condition for recovery is established by simply opening this with a very sharp chisel or a trephine and what needs to be done later on, when it becomes a chronic case is very simple.

In regard to being able to disinfect the canal in chronic osteomyelitis, I would say that after having removed all the sequestra, and having smoothed the surface on the inside, and having cut away enough of the involucrum so that the sides can be folded in without pressure, I do not believe that it is really important that disinfection should be perfect, although every effort should be made to accomplish as nearly perfect disinfection as possible.

Dr. Ryerson spoke about a continuation of bleeding. Bleeding can be stopped by elevating the limb and waiting patiently, but this is not necessary, provided the method I have described is followed. In finishing the operation we are sure to cut away enough bone so that the skin comes together without the slightest tension. We put the patient to bed with the extremity elevated and use large cushions in the dressings in order to secure perfect immobilization. Dr. Schede used cushions of moss, very thick, on all sides and incorporates his splints in these cushions so that any little shock would not disturb the organization of the blood clot. The secret of success lies in leaving the extremity undisturbed for 5 or 6 weeks. By using these thick pads, it is amazing how well the cases do. We have had the same experience with the few cases in which we used Moorhof's plug. They must be undisturbed until the blood clot is changed into connective tissue, so that any additional hæmorrhage is prevented.

CORRESPONDENCE

TRACHELOPLASTY FOR CHRONIC ENDOCERVICITIS

To the Editor: Tracheloplasty, as a curative procedure in the treatment of chronic endocervicitis and the accompanying cellular tissue inflammations, became a widely-accepted addition to the armament of the gynecologist after it was established that cervical lacerations *per se* do not result in chronic endocervicitis but that infection is necessary to produce the typical lesion, that the lymphatics draining the cervix furnish the paths along which extension of the infection and inflammation occur, and that the infected surface does not extend upward beyond the internal os into the corporeal endometrium. The operation of amputation of the cervix has been discarded because it is frequently followed by serious hæmorrhage, because pre-existing menorrhagia or dysmenorrhœa is often intensified, because sterility may be produced in a considerable percentage of cases which might otherwise become pregnant, because premature labor may be brought about in cases which do become pregnant after amputation, and because cervical dystocia is produced in many patients coming to full term. From the mechanical standpoint, trachelorrhaphy cannot be considered a curative agent in cases in which the diseased condition involves more than the angles of a cervix which is lacerated bilaterally. Theoretically, tracheloplasty as advocated and practiced by Sturmdorf, would seem to be the logical form of treatment.

In his book on *Gynoplastic Technology* Sturmdorf, who has made an extensive study of endocervicitis from the standpoint of pathology and curative surgery, states:

"Chronic endocervicitis is primarily and essentially an infection of the deeply situated, terminal tufts of the endocervical muciparous glands. These glandular saccules harbor the infecting organism for years or a life time.

"To cure endocervicitis we must remove the entire infected area of endocervical mucosa; as long as endocervicitis persists, so long will its symptoms persist.

"The cure of chronic endocervicitis demands:

"1. Complete enucleation of the entire endocervical mucosa from the external to the internal os with preservation of the muscular structures.

"2. Accurate relining of the denuded cervical canal by a cylindrical cuff of its vaginal sheath."

He claims for his procedure:

"1. Outlining and free liberation of an ample cuff of mucosa from the vaginal sheath of the cervix.

"2. Enucleation of the entire endocervical mucosa to the internal os, with preservation of its surrounding muscular layer."

Does the operation of tracheloplasty remove the infected and infecting material?

The compound racemose glands of the cervix normally dip very deeply into the surrounding fibromuscular stroma. When their epithelium is penetrated by bacteria, the stroma becomes infiltrated with polymorphonuclear cells and exudation of plasma occurs as the reaction of the tissue. Continued infection followed by exudation and infiltration causes œdema, seen clinically as engorgement, softening, and lividity. Small, round-cell deposition is then seen. Then frequently occlusion of the ducts of nabothian glands occurs with the production of retention cysts, or if suppuration ensues, of abscesses. Sometimes these retention cysts show through the mucous membrane on the vaginal surface of the cervix, which is evidence of the penetrating tendency of the glands in disease.

When retention cysts do not appear on the vaginal surface of the cervix, how far have they penetrated in that direction?

Who can tell, macroscopically, what line limits the extension of infected, hypertrophied glands in that direction?

What is the rationale for the removal of a cone-shaped wedge with the apex at the internal os when there is reason to believe that the infected glands penetrate as deeply in that region as in the neighborhood of the external os?

With these questions in mind the following experiment was tried: In undoubted cases of chronic endocervicitis, after removing a cone-shaped wedge containing the endocervical mucosa after the technique of Sturmdorf, a piece of tissue from the new canal wall was excised, before relining with the mobilized vaginal cuff. This, upon section and staining, showed glandular elements and surrounding inflammatory reaction similar to the tissue removed in the cone-shaped wedge. Repeated confirmation of the results strongly suggest that (a) mere removal of the endocervical musosa does not remove all the infective material; (b) that it is impossible to determine, macroscopically, the limiting point of extension of infection in the direction of, and into the cervical musculature; and (c) that in some instances it is impossible to remove all the infective material without removing musculature in which it is embedded.

Clinical evidence substantiates the experimental indication that the operation does not do what is claimed for it, for many cases followed at the Polhemus Memorial Clinic, even after long-continued, postoperative, local treatment, continue to have symptoms referable only to the continued presence of chronic endocervicitis and the accompanying cellular-tissue inflammation.

That the tendency toward cure of chronic endocervicitis is directly proportional to the approach to an amputation, will, I believe, be attested to by many gynecologists, which in itself is further evidence of the inability to remove all infected material by coning out the endocervical mucosa.

If the rationale for the removal of the cone-shaped wedge as advocated, is the desire to conform to the surgical principle of establishing drainage to eliminate the more deeply situated infection, then that end is defeated by relining what would be the draining surface with the vaginal cuff.

Therefore, since chronic endocervicitis is primarily a condition of infection of the normally deeply-seated terminal tufts of the cervical glands since the glands can and do push deeply into the surrounding structures as a result of such infection; since it is not possible to determine macroscopically the point of termination of such penetration; since there is reason to believe that the limit of possibility of such penetration is not materially lessened as the internal os is approached; since it is not always possible to remove all the infected material without excising some cervical musculature because in some cases the glands dip deeply into the muscle-layer; since, experimentally, infected material has been demonstrated as remaining after the operation; and in view of the fact that follow-up clinical evidence shows a continuance of symptoms after operation, we must cease to expect cures from the operation of tracheloplasty and must seek anew for a cure for chronic endocervicitis. H. KOSTER.

BROOKLYN, N. Y.

BROKEN NECK (?)

To the Editor: In 1889 I was called to see Mrs. A., a primipara in the thirties, small pelvis, labor apparently normal but slow. In due time the forceps were applied, but delivery was slow and difficult. The child's head was in no way injured but the axis and atlas were separated and the child born dead. There were no signs of life after delivery.

1892. Mrs. R., young, second labor, breech presentation and child abnormally large as were all her children. Delivery was difficult and prolonged, and the axis and atlas were separated. There was no signs of life after delivery.

In 1896, I was called to see a child which had been delivered by a midwife a few hours previously. I diagnosed broken neck (separated axis and atlas). The child died in a few hours.

1906. Mrs. — primipara, prolonged labor as the child was large. Forceps used, child delivered, skin macerated, showing child had been dead several days. The axis and atlas were widely separated owing to the severe and continuous pull, showing that even a dead child may be delivered with a broken neck.

July, 1910. Mrs. C., a minister's wife, primipara in the thirties, formerly an assistant school principal. In labor 3 days, dilatation of the cervix very slow with nothing suggesting interference. Right occipitoposterior position. Consultation called. The consultant administered an anæsthetic, forceps were applied (high operation) by the attending physician, and the head was easily brought to the vulva, when the consultant was asked to relieve the operator. He prosecuted the further operation vigorously by sweeping side to side motions instead of direct tension. The child showed signs of life but lived only 25 minutes, although every effort was made by us to save it. The axis and atlas were separated.

1911. Mrs. C., multipara, breech presentation, labor easy, but not without some anxiety about the delivery of the head, but a living child was born. It was weak, never able to hold up its head, always dropping in the direction of gravity, having very little power even while nursing. It developed a pneumonia at the end of two weeks and survived but two days with a most completely solidified right lung. There was a slight separation of the axis and atlas.

1912. Mrs., a multipara, had been in labor since early morning. I was called in consultation at 7 p. m. and found a malposition and dead child. I administered an anæsthetic and the attending physician converted it into a breech position and with much difficulty it was delivered with a separated axis and atlas.

September, 1914. Mrs. L., a primipara, breech presentation, child large to the extreme, very tedious labor. The child was born and a widely-separated axis and atlas was very easily demonstrated to the consultant

To diagnose the separation most easily, let the head drop severely forward with the chin on the chest. There is then a depression between the spinus processes of the two bones sufficient to admit the ball of a small thumb, up to that of a man's owing to the degree of the separation, while the bones of the normal condition are intact.

We often see the statement from the profession that it is not uncommon for a child to die of apoplexy during delivery and possibly much oftener than the

profession is willing to admit, but it is our belief that the condition mentioned above will answer for many of the apoplexies.

I have searched the literature but find nothing on the subject except in Gray's *Anatomy*. After describing the axis and stating that these shapes and conditions are to prevent displacement from the transverse ligaments, which binds it to the anterior arch of the atlas Gray says: "Sometimes, however, this process does become displaced, especially in children in whom the ligaments are more relaxed, and instant death is the result of this accident."

I had no permission to hold an autopsy to prove my findings, neither have I had an opportunity to X-ray any of them.

C. C. HERSMAN, M.D.
PITTSBURGH, PA.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

SIMPLIFIED INFANT FEEDING with eighty illustrative cases. By Roger H. Dennett, B.S., M.D. 2d ed. revised and enlarged. Philadelphia and London: J. B. Lippincott Company, 1920.

HANDBUCH DER KLINISCHEN HYDRO-, BALNEO-, UND KLIMATOTHERAPIE. By Prof. Dr. Alois Strasser, Dr. Franz Kisch, and Prof. Dr. E. Sommer. Berlin and Vienna: Urban & Schwarzenberg, 1920.

TASCHENBUCH DER FRAUENHEILKUNDE. By Dr. Koblanck. 2d ed. revised. Berlin and Vienna; Urban & Schwarzenberg, 1920.

TASCHENBUCH DER AUGENHEILKUNDE; FUER AERZTE UND STUDIERENDE. By Prof. Dr. Curt Adam. 4th ed. Berlin and Vienna: Urban & Schwarzenberg, 1920.

LEHRBUCH DER CHIRURGIE. By Prof. Dr. Carl Garrè and Prof. Dr. A. Borchard. Leipzig: F. C. W. Vogel, 1920.

THE TREATMENT OF WOUNDS OF LUNG AND PLEURA; BASED ON A STUDY OF THE MECHANICS AND PHYSIOLOGY OF THE THORAX; ARTIFICIAL PNEUMOTHORAX; THORACENTESIS; TREATMENT OF EMPYEMA. By Professor Eugenio Morelli; translated from the Italian by Lincoln Davis, formerly Lieutenant-Colonel, M.C., U.S.A., and Frederick C. Irving, Formerly Major, M.C., U.S.A. Boston: W. M. Leonard, 1920.

LEITFADEN DER KINDERHEILKUNDE FUER STUDIERENDE AND AERZTE. By Dr. Walter Birk. 1st part: SAEUGLINGSKRANKHEITEN. 4th ed. revised and enlarged. Bonn: A. Marcus and E. Webers Verlag, 1920.

HUMAN PARASITOLOGY, WITH NOTES ON BACTERIOLOGY, MYCOLOGY, LABORATORY DIAGNOSIS, HEMATOLOGY AND SEROLOGY. By Damasco Rivas, B.S. Biol., M.S., M.D., Ph.D. Philadelphia and London: W. B. Saunders Company, 1920.

THE CATARRHAL AND SUPPURATIVE DISEASES OF THE ACCESSORY SINUSES OF THE NOSE. By Ross Hall Skillern, M.D. 3d ed. thoroughly revised and enlarged. Philadelphia and London: J. B. Lippincott Company, 1920.

DIAGNOSIS AND TREATMENT OF BRAIN INJURIES; WITH AND WITHOUT FRACTURE OF THE SKULL. By William Sharpe, M.D. Philadelphia and London: J. B. Lippincott Company, 1920.

INTERNATIONAL CLINICS; a quarterly of illustrated clinical lectures and especially prepared original articles on treatment, medicine, surgery, neurology, paediatrics, obstetrics, gynæcology, orthopædics, pathology, dermatology, ophthalmology, otology, rhinology, laryngology, hygiene, and other topics of interest to students and practitioners. By leading members of the medical profession throughout the world. Edited by H. R. M. Landis, M.D. Vol. ii, 30th series, 1920. Philadelphia and London: J. B. Lippincott Company, 1920.

THE DUODENAL TUBE AND ITS POSSIBILITIES. By Max Einhorn, M.D. Philadelphia and London: W. B. Saunders Company, 1920.

DISEASES OF CHILDREN PRESENTED IN TWO HUNDRED CASE HISTORIES OF ACTUAL PATIENTS SELECTED TO ILLUSTRATE THE DIAGNOSIS, PROGNOSIS, AND TREATMENT OF THE DISEASES OF INFANCY AND CHILDHOOD; with an introductory section on the normal development and physical examination of infants and children. By John Lovett Morse, A.M., M.D. 3d ed. Boston: W. M. Leonard, 1920.

DIE THERAPIE AN DEN BONNER UNIVERSITAETSKLINIKEN. By Prof. Dr. Rudolf Finkelnburg. Bonn: A. Marcus and E. Webers, Verlag, 1920.

BOOK REVIEWS

A CRITIQUE OF NEW BOOKS IN SURGERY

NO branch in medicine has made greater strides during the past ten years than orthopedic and reconstruction surgery. This cannot be entirely attributed to the stimulus afforded by the recent World War, since much had been attained prior to 1914, and since that date many of the theories have been put into operation, with startling results. As one allows his mind to travel over the progress made in this phase of surgery, one name seems to stand out most prominently, especially as regards operative treatment, and it seems so logical that we should have from Albee's pen the benefits of his vast experience as set forth in his new work on reconstruction surgery.[1] To incorporate in one volume the subject of orthopedic and reconstruction surgery seems to the reviewer not only a convenience but a necessity, since these two subjects bear such a close relation, if they can be separated at all. Whether a deformity or disability be caused by disease or trauma, whether in child or adult, whether of the legs or arms, matters little so far as the treatment may be concerned. The author has in a marked degree clearly emphasized this in his recent work.

Albee has brought closely together the subject of chronic joint troubles, lesions of bones, nerves and muscles. His description of the pathology with associated clinical history and X-ray findings gives a tonic to an apparently dry subject. Probably no part of this new phase in surgery is more spectacular than the possibilities with the bone graft. Its uses have become so widely diversified that the laity and even the medical profession are astounded at the accomplishments. A word of caution may well be added so far as bone transplantation is concerned. No doubt that in the hands of Albee, with his technical experience and skill and with his ability to choose the proper procedure at the proper time and under the proper conditions, bone transplantation becomes an operation with no undue hazards and with results that have no peer. Nevertheless, in the hands of the less experienced, results may not be, and only too frequently are not, what is desired. Such a radical procedure is often chosen because of the brilliant results obtained by such men as Albee, when a much simpler and safer procedure for the individual in question would be the operation wisdom would dictate.

The whole surgical profession owes a debt of gratitude to the author for his untiring efforts in elevating and perfecting the subject of orthopedic and reconstruction surgery and in compiling a volume which incorporates what may be said to be the highest of present day standards of this phase of surgery. J. A. W.

AT the present time many surgeons unfortunately have adopted a certain postoperative routine treatment which is a standing order in the hospital, any deviation from which is more or less at the discretion of the house surgeon. With all due respect to the competent house surgeon and the faithful nurse who attempt to fulfill orders with the best interest of the patient at heart, many avoidable complications occur and patients are often allowed to suffer from conditions which could have been prevented and if present quickly relieved. How many of us have heard the patient bitterly complain of severe backache, intense nausea with vomiting, sleeplessness, and hiccough after operation. Only too frequently are we called upon to treat postoperative acute gastric dilatation, shock and hæmorrhage. Postoperative paralytic ileus, acidosis, and anæmia, are the constant dread of the careful and conscientious surgeon. The recent two volume treatise by Bartlett[2] is indeed opportune. Although the subject has been approached before, never has it been put into such excellent form and covered in such an interesting and complete fashion.

As the author states in the preface: "Such a work naturally divides itself into two parts; one which has to do with general subjects and the other with the measures of after-treatment as they are applied following operations upon the various organs." Hence the two volumes.

The thinking surgeon is not satisfied simply to be told that certain conditions should be treated in a certain way. He wants to know what is the cause, how it can be prevented, as well as how it can be relieved. In no work known to the reviewer are these manifold conditions more clearly discussed.

Volume I gives a classical, comprehensive discussion of every possible condition which may complicate the surgical case; Volume II the possible complications in regional surgical operations.

The work is invaluable to the young surgeon and a necessity for the house surgeon. Every surgeon, be he ever so competent, will read this treatise with great pleasure and benefit. J. A. W.

[1] ORTHOPEDIC AND RECONSTRUCTION SURGERY, INDUSTRIAL AND CIVILIAN. By Fred H. Albee, A.B., M.D., D.Sc., Lieut. Col. M.C., U. S. A. Philadelphia and London: W. B. Saunders Company, 1919.

[2] THE AFTER-TREATMENT OF SURGICAL PATIENTS. By Willard Bartlett, A.M., M.D., F.A.C.S., and collaborators. 2 vols. St. Louis: C. V. Mosby Company, 1920.

THE JOHN B. MURPHY MEMORIAL

THE untimely death of our master surgeon four years ago brought forth an earnest demand for a suitable memorial to commemorate his distinguished services to humanity and to the science and art of surgery.

The John B. Murphy Memorial Association was incorporated at that time by a group of lay and professional friends. However, the entrance of our country into the World War scattered the incorporators and caused a temporary cessation of the activities of the Association.

Six months ago the Executive Board of the Association was reorganized, and the plan of providing a memorial was revived. It was felt by those immediately in charge that a memorial to Dr. Murphy should not be a statue, however heroic, but that it should embody permanence, strength, idealism, purpose, and service. Being agreed upon this basis, it seemed appropriate that this memorial should be allied with a living organization which at the same time would afford an opportunity for a permanent home, the monumental feature of which would serve as the direct expression of those desirous of perpetuating the memory of Dr. Murphy. Therefore, a living, useful, permanent and scientific organization, devoted to the work to which Dr. Murphy gave his life, was sought and found in the American College of Surgeons.

Permanent Home

A few months since, the Board of Regents of the American College of Surgeons decided that the work of the College, which had been greatly hampered during the war, should be developed as rapidly as possible, and that a permanent home for the organization should be established without further delay.

After careful consideration, Chicago was decided upon as the city best serving the required purposes, and a very desirable site, the gift of a number of prominent citizens, was formally accepted by the Regents in behalf of the College. This site comprises a fine building, well adapted to the executive offices of the organization, and also adjacent vacant ground sufficient to accommodate a suitable memorial building.

Memorial Hall

The American College of Surgeons has tendered its vacant property to the Memorial Association with the stipulation that the latter Association build upon it a permanent structure to be known as the John B. Murphy Memorial Hall of the American College of Surgeons. This building, upon which the Association contemplates expending approximately Four Hundred Thousand Dollars, will become the property of the American College of Surgeons and will be maintained in perpetuity by that organization.

The proposed building will meet the essential requirements hereinbefore outlined; permanency is assured; the memorial will be in the form of a living power for the advancement of surgery along scientific and moral lines; architecturally, it will constitute a dignified and ornamental monument, and in form

and use it will satisfy the people among whom Dr. Murphy was most active that their monument will perform a service that will benefit all peoples for generations to come.

Biographical

The readers of Surgery, Gynecology and Obstetrics do not require any reminder of the power and influence of this world-famed surgeon; but his reputation among the people of all walks of life, as related in the pamphlet issued by the Memorial Association, is interesting:

John B. Murphy, M.D.

The death of Dr. John B. Murphy on August 11, 1916, was a great shock to Chicago, his home city. But Dr. Murphy, pre-eminently, was not only a local figure, but, to a degree attained by few, he was a citizen of the world, and his passing away was profoundly felt in London, Paris, Berlin, Petrograd, New York, and San Francisco. The tributes paid to him at the time of his death are still interesting as proving how a big man, regardless of his calling, may rise above his contemporaries and at his death be sincerely mourned, not only by the multitude whom he served in such a remarkable way in the practice of his profession, but by the world-leaders, men of intelligence and vision, who appreciated him during his life and who will always delight to honor his memory.

Expressions of Appreciation

Excerpts from some of the hundreds of messages received at the time of Dr. Murphy's death will serve to prove what the world thought of him and so help to form a proper estimate of his real worth. From national leaders: Woodrow Wilson, Washington, D. C.: "The medical world loses one of its foremost figures and our country sustains a real loss. I am sure I express the feeling of the whole country when I mourn his going." Theodore Roosevelt, Oyster Bay: "Dr. Murphy was one of the most useful men in this country and one of the men who added to our perpetuation all over the world. He was a great surgeon of international reputation and he was as staunch and whole-hearted a patriot as this country ever had. He was a great American citizen."

From the Church, Dr. Murphy received his greatest tribute while living. In recognition of his services to humanity and of his many works of Christian charity, His Holiness, Pope Benedict XV, bestowed upon him the honor of Christian Knighthood together with the Apostolic Blessing. Upon his death, many leaders of his Church sent their expressions of sorrow and their great appreciation of the loss suffered by the world.

From Europe: Sir Rickman J. Godlee, Bart., K.C.V.O., F.R.C.S., London, England: "I fell under the spell of his most original eloquence, which made hidden things clear and shed over well-known facts such a glamour that one seemed to be hearing of them for the first time from the lips of their discoverer. America has lost an incomparable teacher as well as one of her greatest surgeons." Sir Arbuthnot Lane, Bart., C.B., F.R.C.S., London, England: "Very few men have possessed his wonderful personality and attractiveness quite apart from his extraordinary originality and skill."

The medical profession, from the Atlantic to the Pacific, sent numberless tributes. Among them, William J. Mayo, M.D., Rochester, Minnesota: "In the death of Dr. Murphy, America has lost its foremost surgeon." George W. Crile, M.D., Cleveland, Ohio: "His teachings have influenced not only the American continent, but also Europe and the far East, for Murphy taught the world." Charles H. Mayo, M.D., Rochester, Minnesota: "He was the greatest surgical teacher of his time." John A. Wyeth, M.D., New York City: "The world owes him much for thought and deed." J. M. T. Finney, M.D., Baltimore, Maryland: "A wonderful personality, an inspiring teacher, a splendid surgeon, a true friend, a real man; his going has left a gap that can never be filled." Arthur L. Lynch, M.D., Saskatoon, Saskatchewan: "Not only have the surgeons of America as well as Canada lost one of the ablest and foremost teachers of the age, but suffering humanity will feel just as keenly the death of Dr. Murphy." Ingersoll Olmsted, M.D., Hamilton, Ontario: "He was as well known here as at his home in Chicago."

From his home city expressions of a similar nature were practically unanimous. A limited number only will serve our purpose. A. J. Ochsner, M.D.: "Dr. Murphy was the one man whom the whole surgical world knew as a great American surgeon." W. A. Evans, M.D.: "He was the greatest surgeon of his day in the world." Frank Billings, M.D.: "Dr. Murphy is gone, but his work will live. We soon forget, but we remember great landmarks." Arthur Dean Bevan, M.D.: "He was one of the most original thinkers American surgery has produced."

Among the miscellaneous tributes from leaders in American life: Edmund J. James, President, University of Illinois: "The world has lost one of its most efficient and helpful citizens." Judge Edward O. Brown, Chicago: "All the world knows of his great genius and his devotion to the services of humanity."

Summary

Dr. Murphy's worth and leadership, so far as the worth and leadership of a genius can be analyzed, may be summarized as follows: Gifted with extraordinary native ability, he concentrated on a great struggle to realize his ideal of a life full of useful service. He mastered the fundamental principles and the mechanical technique of an exacting science. By drill and discipline, he became master in the fields of the art and science of medicine, and solved by original investigations the intricate problems of his art. His contemporaries acknowledge that the scientific contributions of Dr. Murphy for the advance of medicine and surgery have never been equaled, either in range or in worth, by any other individual in the profession. As a teacher with power to inspire young men to their greatest usefulness, both in the science of medicine and as citizens, Dr. Murphy stood without peer. His charm, kindness, force, and the ability to untangle difficult propositions by simple, clear-cut exposition, gave him rank as the great surgical teacher of his age. He went from task to task with complete simplicity. He was the good neighbor; he chose his friends for their honor and worth, not for their position or reputation. His greatest pleasure was attained in his home with his wife and children. Dr. Murphy was true to his convictions. He possessed a clean conscience, a profound religious sense, and a constant devotion to the Church of which he was a communicant.

Physicians' Advisory Committee

E. Wyllys Andrews, Chicago
George E. Armstrong, Montreal
Arthur Dean Bevan, Chicago
Frank Billings, Chicago
John F. Binnie, Kansas City
Joseph A. Blake, New York
Joseph C. Bloodgood, Baltimore
George E. Brewer, New York
Norman Bridge, Los Angeles
Truman W. Brophy, Chicago
Robert C. Coffey, Portland
George W. Crile, Cleveland
Harvey Cushing, Boston
James B. Eagleson, Seattle
J. M. T. Finney, Baltimore
William W. Grant, Denver
William D. Haggard, Nashville
Howard A. Kelly, Baltimore
Fred B. Lund, Boston
Edward Martin, Philadelphia
Rudolph Matas, New Orleans
William J. Mayo, Rochester
L. L. McArthur, Chicago
Stuart McGuire, Richmond
Lewis S. McMurtry, Louisville
Harvey G. Mudd, St. Louis
Henry P. Newman, San Diego
Albert J. Ochsner, Chicago
A. Augustus O'Neill, Chicago
Eric P. Quain, Bismarck
William E. Quine, Chicago
Witten B. Russ, San Antonio
Henry H. Sherk, Pasadena
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George David Stewart, New York
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Frank Matthiessen
Robert R. McCormick
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Mark Morton
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Max Pam
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John Barton Payne
Frank S. Peabody
A. D. Plamondon
Marvin B. Pool
Alexander H. Revell
George M. Reynolds
Benjamin J. Rosenthal
Harry Rubens
S. C. Scotten
John C. Shaffer
James Simpson
Silas Strawn
Roger C. Sullivan
B. E. Sunny
Robert J. Thorne
William A. Tilden
Fred W. Upham
Frank O. Wetmore
Walter H. Wilson
John H. Wood
William Wrigley, Jr.

Note.—Next month's issue of Surgery, Gynecology and Obstetrics will give the definite plan of the Executive Board in its campaign to raise funds for building and maintaining this monument to one of the world's greatest surgeons. In the meantime, a substantial number of large subscriptions are being received by the Board. Information in regard to the plan which is being formulated for subscriptions may be obtained through the President of the Board, Mr. Edward N. Hurley, Room 1314, 30 North Michigan Avenue, Chicago.

AMERICAN COLLEGE OF SURGEONS

ORGANIZATION OF STATE AND PROVINCIAL CLINICAL SECTIONS

Montana, Idaho, Oregon, and Washington Lead in Holding First State Meetings

STATE sectional meetings of the Clinical Congress of the American College of Surgeons have been definitely arranged as follows:

Montana—Butte, September 3 and 4.

Idaho—Boise, September 6 and 7.

Oregon—Portland, September 10 and 11.

Washington—Seattle, September 13, 14 and 15.

By co-operation with the central office of the College, these four meetings have been planned as a series which will make it convenient for those in attendance from outside of the state to visit all of them in succession.

In each of these states morning and afternoon clinics have been arranged by the Fellows of the College in the cities in which the meetings are to be held. A large afternoon meeting for prominent lay men and women of the respective cities and states and a series of evening literary sessions to consider scientific surgical subjects have been announced.

Besides the local talent that will be called upon to entertain at the various meetings, Dr. William D. Haggard, Nashville, Professor of Surgery of Vanderbilt University and a Regent of the College, and Dr. Frederic A. Besley, Chicago, Professor of Surgery of Northwestern University, have accepted invitations and will deliver addresses at the afternoon meeting for citizens. They will also deliver addresses on live surgical subjects at an evening meeting in each state. The Director of the College will be present at these various meetings and at one session in each state he will deliver a talk on the work of the College in connection with the standardization of hospitals, and point out how the state meetings can assist in this important work. The Secretary-General of the College will attend the sessions in each state and will speak on the organization work of the different state sections, and the future work of the College that can be aided by these decentralized organizations.

The office of the General Manager of the Clinical Congress of the American College of Surgeons will be represented at each of the meetings by Mr. T. E. Allen and Mr. R. U. Myers. This will insure close co-operation between the central office and the executive committees of the states in the conduct of these meetings, and will aid greatly in carrying out the many details so important to the success of any scientific meeting.

State Clinical Sections Already Organized

During the month of July State Sections of the Clinical Congress of the American College of Surgeons were formally organized in Iowa, Minnesota, North Dakota, South Dakota, and Nebraska.

The Executive Committees and State Representatives of these States are as follows:

IOWA

Executive Committee

Chairman, W. W. Pearson, Des Moines
Secretary, J. C. Rockafellow, Des Moines
Counselor, Donald Macrae, Jr., Council Bluffs

Representatives, Term Expiring 1920

Senatorial, J. C. Rockafellow, Des Moines
2nd District, David S. Fairchild, Sr., Clinton
4th " William J. Egloff, Mason City
6th " David C. Brockman, Ottumwa
8th " Thomas E. Powers, Clarinda
10th " W. W. Bowen, Fort Dodge
At Large. Lee Wallace Dean, Iowa City

Term expiring 1921

Senatorial, W. W. Pearson, Des Moines
1st District, Charles P. Frantz, Burlington
3rd " William B. Small, Waterloo
5th " Aram G. Hejinian, Anamosa
7th " Francis E. V. Shore, Des Moines
9th " Donald Macrae, Jr., Council Bluffs
11th " William Jepson, Sioux City

MINNESOTA

Executive Committee

Chairman, Thomas McDavitt, St. Paul
Secretary, Arthur T. Mann, Minneapolis
Counselor, Charles H. Mayo, Rochester

Representatives, Term expiring 1920

Senatorial, Edward S. Judd, Rochester
2nd District, John W. Andrews, Mankato
4th " Thomas McDavitt, St. Paul
6th " Rowland T. S. Gilmore, Bemidji
8th " William H. Magie, Duluth
10th " Henry C. Cooney, Princeton

Term expiring 1921
Senatorial, Amos W. Abbott, Minneapolis
1st District, Melvin S. Henderson, Rochester
3rd " Laura A. Lane, Faribault
5th " Arthur A. Law, Minneapolis
7th " John J. Donovan, Litchfield
9th " Theodor Bratrud, Warren

NORTH DAKOTA

EXECUTIVE COMMITTEE
Chairman, Eric P. Quain, Bismarck
Secretary, N. O. Ramstad, Bismarck
Counselor, J. W. Bowen, Dickinson

REPRESENTATIVES, Term Expiring 1920
Senatorial, Paul Sorkness, Fargo
2nd District, N. O. Ramstad, Bismarck
At Large, Eric P. Quain, Bismarck

Term expiring 1921
Senatorial, Robert D. Campbell, Grand Forks
1st District, Murdock MacGregor, Fargo
3rd " Alexander J. McCannel, Minot

SOUTH DAKOTA

EXECUTIVE COMMITTEE
Chairman, Robert D. Alway, Aberdeen
Secretary, Frederick A. Spafford, Flandreau
Counselor, Charles E. McCauley, Aberdeen

REPRESENTATIVES, Term expiring 1920
Senatorial, John W. Freeman, Lead
2nd District, Robert D. Alway, Aberdeen
At Large, Byron A. Bobb, Mitchell

Term expiring 1921
Senatorial, Frederick A. Spafford, Flandreau
1st District, Frank I. Putnam, Sioux Falls
3rd " Frank S. Howe, Deadwood

NEBRASKA

EXECUTIVE COMMITTEE
Chairman, John E. Summers, Omaha
Secretary, Daniel T. Quigley, Omaha
Counselor, J. Stanley Welch, Lincoln

REPRESENTATIVES, Term expiring 1920
Senatorial, Daniel T. Quigley, Omaha
2nd District, Palmer Findley, Omaha
4th " Harry M. Hepperlen, Beatrice
6th " Francis A. Long, Madison

TERM expiring 1921
Senatorial, John P. Lord, Omaha
1st District, David Clark Hilton, Lincoln
3rd " C. A. Allenburger, Columbus
5th " B. B. Davis, Omaha

The following states have now organized clinical sections:

North Carolina	Missouri	Connecticut
Louisiana	Tennessee	Massachusetts
Texas	Kentucky	Maine
Arizona	Ohio	New Hampshire
California	Indiana	Vermont
Oregon	Pennsylvania	Iowa
Washington	Illinois	Minnesota
Idaho	Wisconsin	North Dakota
Montana	Michigan	South Dakota
Utah	New York	Nebraska
Colorado	Rhode Island	

It is important that the executive committees of the states already organized shall meet at an early date for the purpose of selecting the time and formulating tentative plans for their first sectional meeting. We are endeavoring to arrange these meetings in various parts of the country in such a way that representatives from the central office and speakers can visit more than one state in the district on a trip. Therefore, we are asking the state executive committees to notify the central office as soon as a tentative date for the first sectional meeting has been decided upon so that plans for the other state meetings may be formulated accordingly.

ANNUAL SESSION OF THE CLINICAL CONGRESS

The tenth annual session of the Clinical Congress of the American College of Surgeons will be held at the Windsor Hotel at Montreal during the week of October 11th of this year. It is proposed to hold meetings of all executive committees of the various states and provinces at some time during this week. At this meeting there will be discussions of problems incident to the organization of the state clinical sections and the conduct of the first annual clinical meetings. Formal notice of time and place of this meeting will be sent in advance to all members of the executive committee.

PLAN OF STATE ORGANIZATION

The plan of state organization, approved by the Board of Regents and state representatives present at the New York Congress last October, consists of:

1. All Fellows of the College resident within the state, to be known as "The (name of state) Section of the Clinical Congress of the American College of Surgeons."

2. A body of state representatives, one from each congressional district and two from the state at large, each to be elected by the Fellows of the state for a term of two years, one-half the number to be elected each year. This body shall correspond in the state to the Board of Governors of the College.[1]

3. An executive committee to consist of three or five Fellows, to be elected annually by the state representatives from among the Fellows of the state. The executive committee shall correspond to the Board of Regents of the College and be the supreme executive body within the state in the conduct of state clinical meetings.

The officers of the executive committee shall be a chairman and a secretary. The chairman shall preside at all meetings of the ex-

[1] Similar organizations will be effected in the provinces of Canada.

ecutive committee and of the state representatives and be the president of the annual session of the clinical section. The secretary shall act also as secretary of the state representatives and of the state section. In the event of the death, resignation, or withdrawal from the state of the chairman, a counselor, to be known as the vice-chairman, shall assume the duties of the chairman until that office is filled by election at the next meeting of the state representatives.

The duties of the executive committee shall be those ordinarily performed by a governing board, namely:

1. To conduct annual state clinical meetings as hereinafter provided;

2. To create, appoint, and direct all committees;

3. To direct the manner in which the books and accounts of the section shall be kept, and cause to be examined from time to time its accounts and vouchers for moneys received and paid out, and submit the same to the central office for approval;

4. To keep a record of state proceedings, and submit a report regarding such proceedings to the state representatives for approval at the next succeeding meeting, and to the central office.

The executive committee shall hold meetings at such time and place as it may from time to time determine.

ANNUAL SESSIONS

State sections when organized shall proceed with plans for the first annual session of from two to three days at such time and place as may be determined upon by the executive committee, which may include:

1. Surgical and diagnostic clinics and clinical demonstrations to be conducted during the morning by Fellows of the College, and by their associates, of the city in which the meeting is held. These clinics may provide practical demonstration of the group method of diagnosis and teaching, in co-operation with internists, pathologists, roentgenologists and other specialists of medicine;

2. Afternoon meetings for the laity, to be addressed by invited laymen and surgeons;

3. Scientific and literary papers relating to the art and science of surgery, to be presented at evening meetings by local surgeons of prominence and by invited guests from outside the state or province;

4. Annual meeting of the state section, of the state representatives, and of the executive committee.

COMMITTEE ON INVITATIONS

The committee on invitations should represent all parts of the state in order that no medical man of prominence will be omitted from the invitation list. This committee shall determine the number of invited guests, based on the following:

Attendance at the clinical sessions shall be limited to Fellows of the College and invited guests, the latter to include candidates for Fellowship, approved ethically by the respective State Credentials Committee, and include also internists, pathologists, roentgenologists, editors of medical journals, and other medical men of influence. Invitations to attend the afternoon meetings shall be extended to the Chamber of Commerce, the members of the Rotary Club and their wives, the Women's Club, and other prominent lay organizations and individuals.

COMMITTEE ON ARRANGEMENTS

The committee on arrangements, composed of local Fellows, shall visit the hospitals of the city in which the meeting is to be held and make all arrangements for clinics and clinical demonstrations and see that accommodations are provided for the number of men who will attend.

This committee shall reserve accommodations in the best hotels in the city far enough in advance of the meeting to insure entertainment of all guests and Fellows who are expected to attend.

The hotel selected for headquarters should provide:

1. A ballroom or assembly hall for afternoon and and evening meetings;

2. Room adjoining to be used as headquarters of the annual session and for registration and ticket bureau;

3. Corridor to be used for the display of clinical bulletins.

Note. It is desirable that all of these rooms be on the same floor. In case the hotel cannot provide a large assembly room, a suitable auditorium in the city should be secured for afternoon and evening meetings.

The committee on arrangements shall appoint a capable person to act under its direction as editor of the daily clinical bulletin and provide a stenographer familiar with medical terms to receive reports of the coming day's clinics for this bulletin.

HOSPITALS

Each hospital in which clinics are to be given shall appoint a committee of three, representing all services, which shall be responsible for the conduct of the clinics held in that hospital. One member of this committee shall be specifically

charged with the duty of transmitting each afternoon to the bulletin editor at headquarters a list of the coming day's clinics. Each hospital shall provide an individual who shall honor or take up the tickets issued at headquarters for each specific demonstration.

PUBLICITY COMMITTEE

Impersonal ethical publicity is essential in order that the annual state clinical sessions may exercise the widest influence. To this end a publicity committee, appointed by the executive committee, shall see that invitations to all open meetings and summaries of the daily clinical bulletins are given to properly selected sources of publicity. All reports of clinical procedure submitted to the public press shall be carefully censored by the publicity committee, which shall see that nothing is published that does not conform to the strictest standards of professional ethics.

FINANCES

It is the wish of the College that no extra expense be incurred by the members of the College of the city in which the meeting is held. An allowance of not to exceed $3.00 a year for each member of the College in the state will be made by the central office to help defray the expense of conducting the annual state clinical sessions. There will be no individual registration fee.

Exhibits by publishing houses and dealers in surgical instruments and supplies may be arranged for at the discretion of the executive committee.

CO-OPERATION OF THE CENTRAL OFFICE

A representative from the central office will work with the executive committee and cooperate as far as may be necessary in carrying out the details of arrangements at headquarters, prepare tickets, clinical bulletins, and assist in the smooth running of the meeting. The central office will aid through recommendation in the selection, not only of orators for the afternoon lay meetings, but also of speakers of note for the evening sessions. To this end it is essential that the secretary of the executive committee shall at all times keep in close touch with the central office of the College.

HOSPITAL STANDARDIZATION IN CANADA

THE following paper, addressed to the Canadian Medical Association in session at Vancouver, June 22-26, and written by Dr. M. T. MacEachern, President of the British Columbia Hospital Association, is of interest.

Foreword: The vital question confronting the hospitals of Canada today is that of hospital standardization. The subject is just as vital to the medical profession. This résumé sets forth briefly the nature of the work, what has been done, and what remains to be done. It is presented in the hope that both the hospitals and the profession will join more earnestly in that sort of constructive action which will create Class A hospitals throughout Canada.

* * * * * *

If the medical profession is to advance scientifically and otherwise, and to retain the confidence of the public, it must create hospitals which protect our right to be well. It must create hospitals wherein every man, woman, and child admitted receives the best care possible for the profession to give. After years of study, both the hospitals and the profession have agreed upon the most direct and practicable route to that ideal. The route is known as the minimum standard of the American College of Surgeons. There is nothing new about it, and there is nothing debatable about it. The thing needed is merely swifter action springing out of the deepest seriousness of the profession, in order that the ideal come true.

In any community an intimate relation must exist between the hospital and the profession. To standardize one is to standardize both; and to standardize both is to create an ever increasing scientific ability on the part of the doctors and an effective application of that ability to the welfare of patients.

The patient is the unit of consideration and the bond between the hospital and the doctor. If this is true, then the motto of both must be *one hundred per cent efficiency in the care of all patients.* Rich and poor, without regard to color or creed, come within this conception. Is there any nation in the world which can outdo the profession in Canada in such a program?

Now let us take a plain inventory of ourselves. In Canada is a group of hospitals outstanding for their merit throughout the world. That fact is a delight; but it should not detract our attention from the whole picture of Canadian hospitals. Many in the picture came recently into existence. They "grew over night," and in some instances have little or no knowledge of the true ideal for which hospitals are intended. Many are badly planned, inadequately equipped, and inefficiently personnelled. Many are poorly financed, depending for their existence as the alms seeker does on the streets. Many, with good intentions enough, are merely boarding houses for sick people. Such institutions say with a sort of pathetic sentimentality: "We take splendid care of all our patients." But they have not the facts on which to base such a claim.

A real hospital *knows* what kind of care its patients receive; it *knows* that when mistakes occur they do not occur again through avoidable reasons. The time has come when any hospital in Canada must either be in possession of such procedure or resign all right to the confidence, goodwill, and support of the public.

We do not have too many hospitals. We do not have enough hospitals. Our business, then, is not destructive. Our business is to accept the facts as they are and then, with all the combined common sense which we possess, to change the poor or mediocre facts into ones of excellence. That process is hospital standardization.

For seven years, silently but energetically and effectively, hospital standardization has been developing until it now permeates almost every institution on our continent and is making its influence felt because it is recognized as a simple, practical, and rational basis for the best work and in the best interests of the doctor, the patient, the hospital, and the community. To the American College of Surgeons, a splendid body of men from Canada and the United States, we owe the commencement and development of the movement. They had foresight and vision of the future and they were sincere, as evidenced by their giving from their own means toward this movement. Now the work is being carried on from coast to coast with splendid response from our hospitals and the profession.

In briefly reviewing the progress of this movement we find it started in 1913 and for the first two or three years data were secured by correspondence, by visits, and by personal contact with hospitals, doctors, boards of trustees, and others. This information was very carefully digested by the group making the study and after due deliberation the minimum standard requirement was formulated. This standard is as follows:

1. That physicians and surgeons privileged to practice in the hospital be organized as a definite group or staff. Such organization has nothing to do with the question as to whether the hospital is "open" or "closed," nor need it affect the various existing types of staff organization. The word staff is here defined as the group of doctors who practice in the hospital inclusive of all groups such as the "regular staff," the "visiting staff," and the "associate staff."

2. That membership upon the staff be restricted to physicians and surgeons who are (a) competent in their respective fields and (b) worthy in character and in matters of professional ethics; that in this latter connection the practice of the division of fees, under any guise whatever, be prohibited.

3. That the staff initiate and, with the approval of the governing board of the hospital, adopt rules, regulations, and policies governing the professional work of the hospital; that these rules, regulations, and policies specifically provide:

a. That staff meetings be held at least once each month (in large hospitals the departments may choose to meet separately).

b. That the staff review and analyze at regular intervals the clinical experience of the staff in the various departments of the hospital, such as medicine, surgery, and obstetrics; the clinical records of patients, free and pay, to be the basis for such review and analyses.

4. That accurate and complete case records be written for all patients and filed in an accessible manner in the hospital, a complete case record being one, except in an emergency, which includes the person's history; the physical examination, with clinical, pathological and X-ray findings when indicated; the working diagnosis; the treatment, medical and surgical; the medical progress; the condition on discharge with final diagnosis; and, in case of death, the autopsy findings when available.

5. That clinical laboratory facilities be available for the study, diagnosis, and treatment of patients, these facilities to include at least chemical, bacteriological, serological, histological, radiographic, and fluoroscopic service in charge of trained technicians.

That standard is not, perhaps, so simple as it looks. But certainly it does not impose too large a burden of effort upon the doctor or upon the hospital. It calls for no undue expenditure of money. It is not impertinent, for it is based upon the sound principles of practice which the profession long ago accepted. It forces a constructive and co-operative scrutiny over all medical work in the hospital; unnecessary surgery, incompetent surgery, lax and lazy medical service, and all commercialism in medicine go down before it.

The minimum standard is not a theory. Wherever it is tried with sincerity, it succeeds. One result of it, too, is that it swiftly submerges personal prejudices among doctors and unites them under those bonds which have always made the profession great.

The second phase of the work consisted in a survey of the hospitals of Canada and the United States of one hundred beds and over, in order to bring to them the minimum standard and assist them in carrying it out. Six hundred and seventy-one hospitals of one hundred beds and over, in both countries, were surveyed and it was found that only eight-nine were then living up to the requirements of the standard. The policy pursued, however, was to make it as comprehensive as possible to all these institutions and to help them to fall into line. During the past year another review has been completed and it is found that of these six hundred and seventy-one hospitals, one hundred and ninety-eight have complied with the conditions as laid down. During the present year the field is being actively and thoroughly worked and all hospitals of fifty beds and over are being reviewed. It is expected that possibly four hundred, at least, of the six hundred and seventy-one hospitals already referred to, will have reached the requirement. The workers are receiving great encouragement everywhere they go.

A splendid impetus to this movement in Canada was given last year when Mr. John G. Bowman, director of the American College of Surgeons, and Father Moulinier, president of the Catholic Hospital Association, made a tour through Canada. Their work has been followed up and augmented by others and no doubt a complete report of this will be made during the coming autumn in Montreal at the International Meeting.

In western Canada material progress has been made. A conference was held at Calgary on April 26 and 27, 1920, at which representatives from the various hospitals in the four western provinces—Manitoba, Saskatchewan, Alberta, and British Columbia, consisting of hospital superintendents, members of boards, Fellows of the American College of Surgeons, and others, met to discuss hospital standardization primarily. We found that great progress had already been made in the western provinces. Many hospitals in Manitoba, Saskatchewan, Alberta, and British Columbia had adopted the minimum standard in its full requirement. A splendid meeting was held, lasting two days. The Western Canada Hospital Association was formed, having primarily for its object the advancement of hospital standardization in western Canada. Several very valuable resolutions were passed by this conference which are of vital importance to hospital standardization. The conference very strongly approved and supported the minimum standard requirement and recommended its adoption by all the hospital associations and hospitals of the four provinces. The conference also approved of and recommended highly the plan of having a hospital association in each

province to promote the welfare of our institutions, and they also recommended that the Canadian Hospital Association, which has been inert for the past few years, be revived. Through such organizations it is hoped to assist in the promotion of hospital standardization. The work of the Province of British Columbia has been taken care of by Dr. T. R. Ponton, assistant superintendent and director of medical records of The Vancouver General Hospital, and myself, and all the hospitals of fifty beds and over have been reviewed. Our work has recently been extended to the four western provinces and a review will be made in the course of the summer. It is indeed gratifying to find that this work is being welcomed by the hospital people and the medical profession wherever we go, and we trust that before long we will not have any institution in western Canada which cannot claim the distinction of "Class A."

In conclusion let me say that the doctors in Canada are of such character and training that they will carry this program out, but let me appeal to you, with all the force in me, for speed of action. Let us have Canada in the lead, which means that there shall be a series of hospitals from the Pacific to the Atlantic in which every patient gets the best service always, which the profession can give. Let us have in Canada the first such series of hospitals across the continent.